A1-F18AC-SRM-300
1 December 1992
Change 6 - 15 November 2002

TECHNICAL MANUAL

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

NAVY MODEL

F/A-18A/B/C/D

161353 AND UP

This volume is one of two volumes and is incomplete without A1-F18AC-SRM-310.

This volume contains WP001 00 through WP037 00.

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NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES/PAGES

List of Current Changes

Original............0............1 Dec 92
Change ....1 ....15 Mar 93
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Only those work packages/pages assigned to the manual are listed in this index. Insert Change 6, dated 15 November 2002. Dispose of superseded work packages/pages. Superseded classified work packages/pages shall be destroyed in accordance with applicable security regulations. If changed pages are issued to a work package, insert the changed pages in the applicable work package. The portion of text affected in a change or revision is indicated by change bars or the change symbol “R” in the outer margin of each column of text. Changes to illustrations are indicated by pointing hands, change bars, or MAJOR CHANGE symbols. Changes to diagrams may be indicated by shaded borders.

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037 00 reserved	0

LIST OF TECHNICAL PUBLICATION DEFICIENCY REPORTS INCORPORATED

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

This WP supersedes TPDR WP, dated 1 August 1998.

1. The TPDRs listed below have been incorporated in this issue.

IDENTIFICATION NUMBER/ QA SEQUENCE NUMBER	LOCATION
65888-02-0818	WP014 02

ALPHABETICAL INDEX

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

This WP supersedes WP001 00, dated 15 February 1994.

WORK PACKAGE INDEX

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

This WP supersedes WP 001 01, dated 15 February 1994.

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION INDEX

Reference Material

None

Alphabetical Index

Record of Applicable Technical Directives

None

1. **NONDESTRUCTIVE INSPECTION INDEX.** See figure 1.

2. This work package shows location of each component, on next higher structural group, covered in specific procedure work packages in this manual. An index number is assigned each component. When required for clarity component is shown in detail.

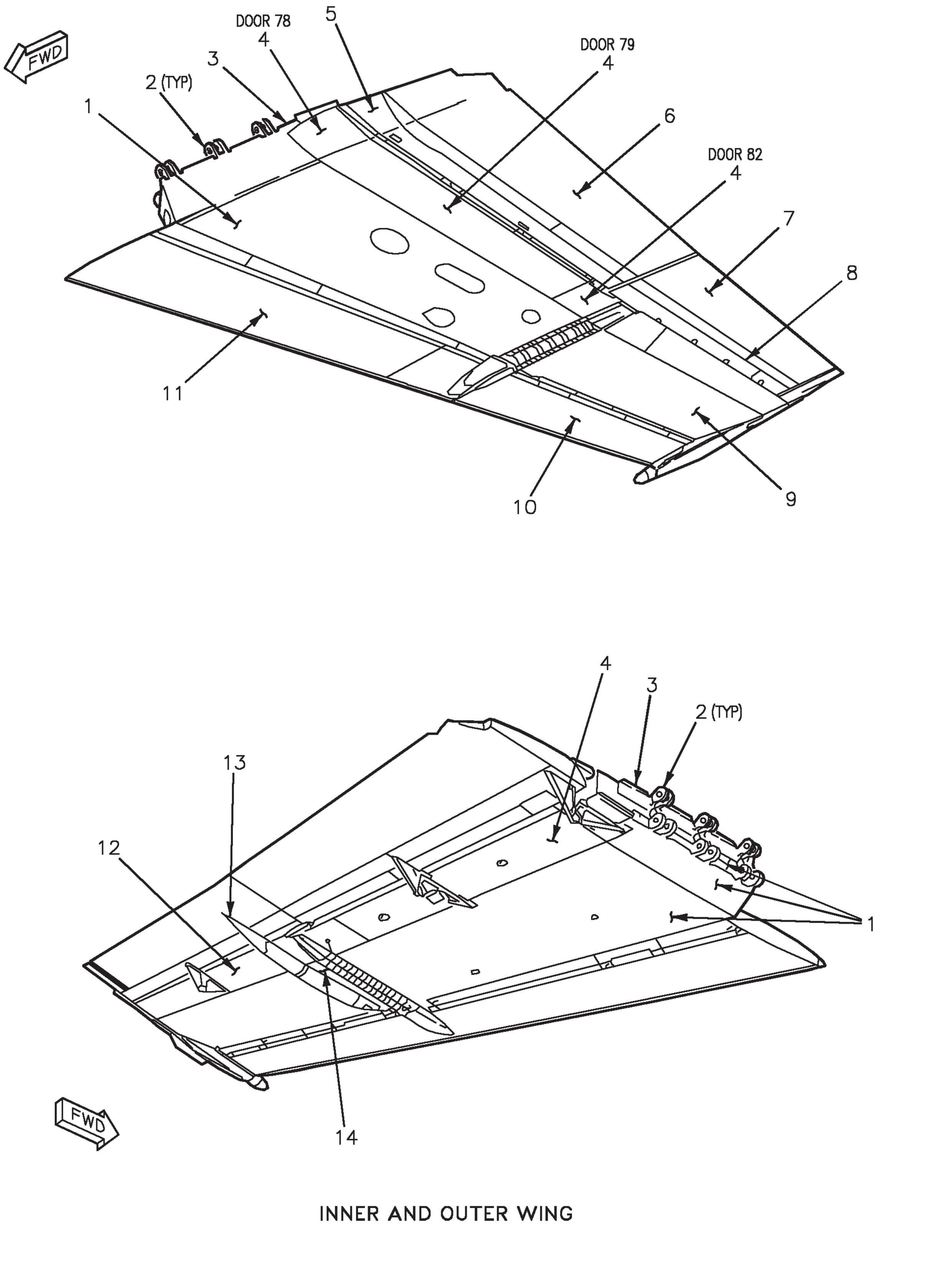


Figure 1. Nondestructive Inspection Index (Sheet 1)

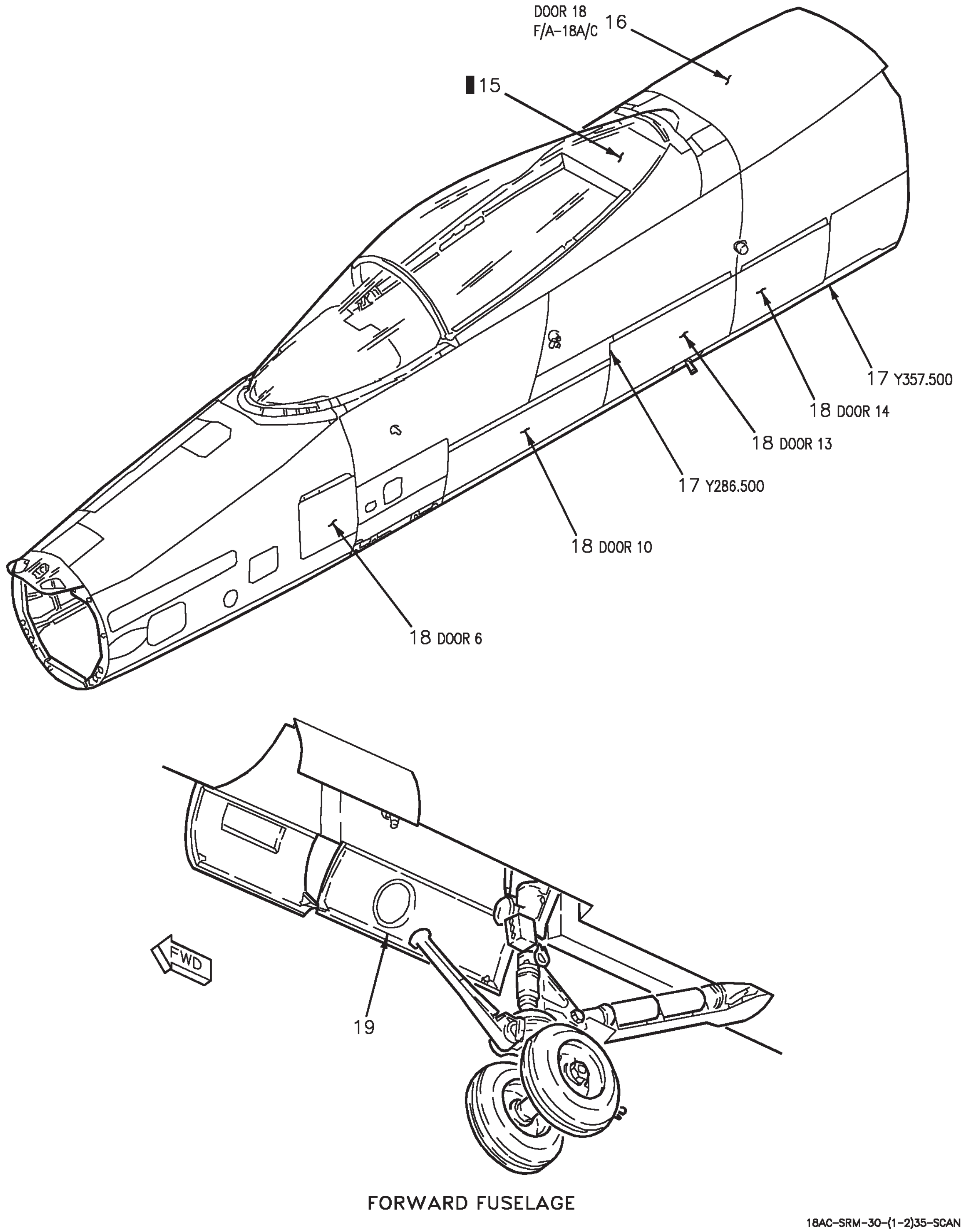


Figure 1. Nondestructive Inspection Index (Sheet 2)

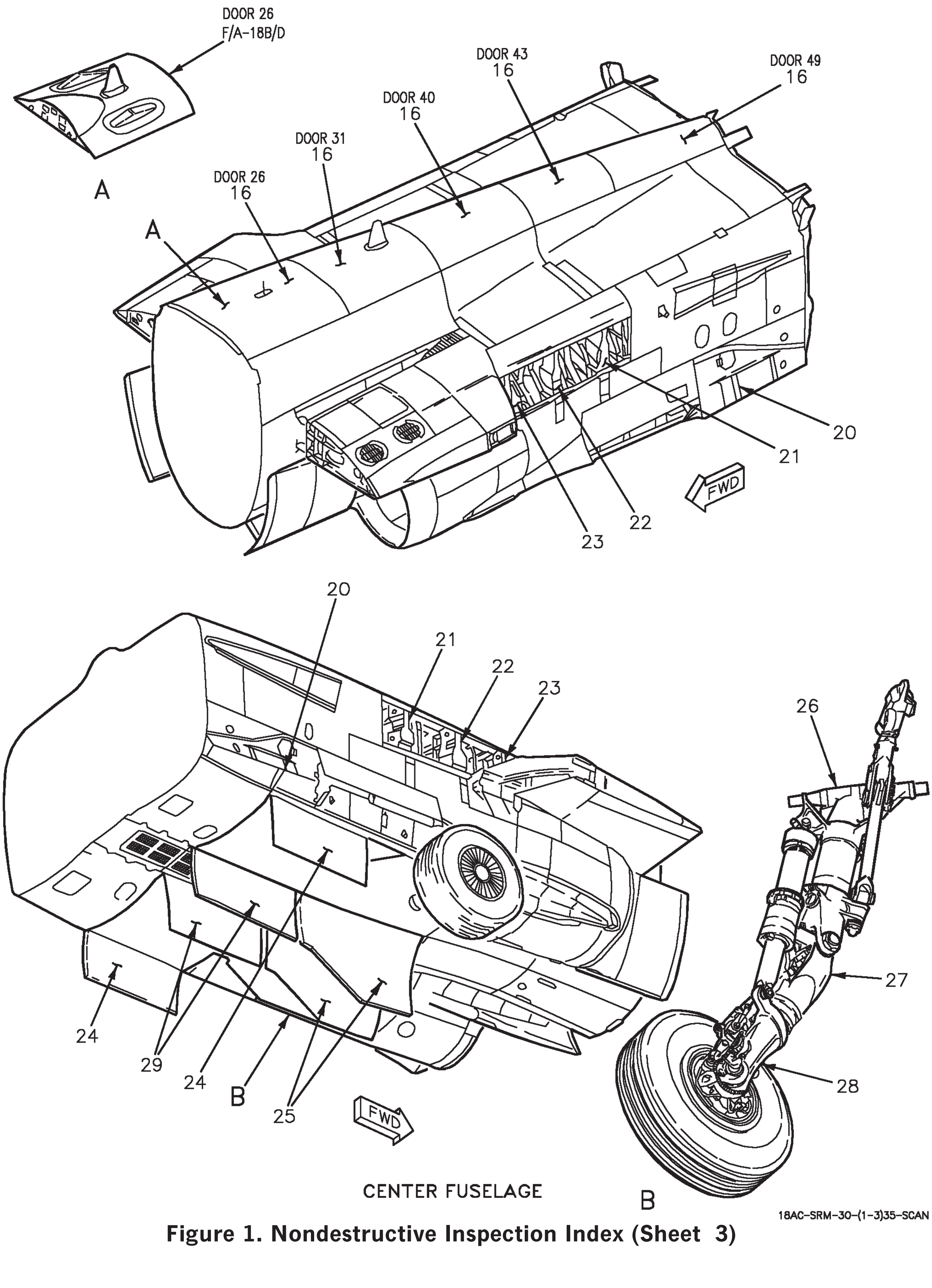
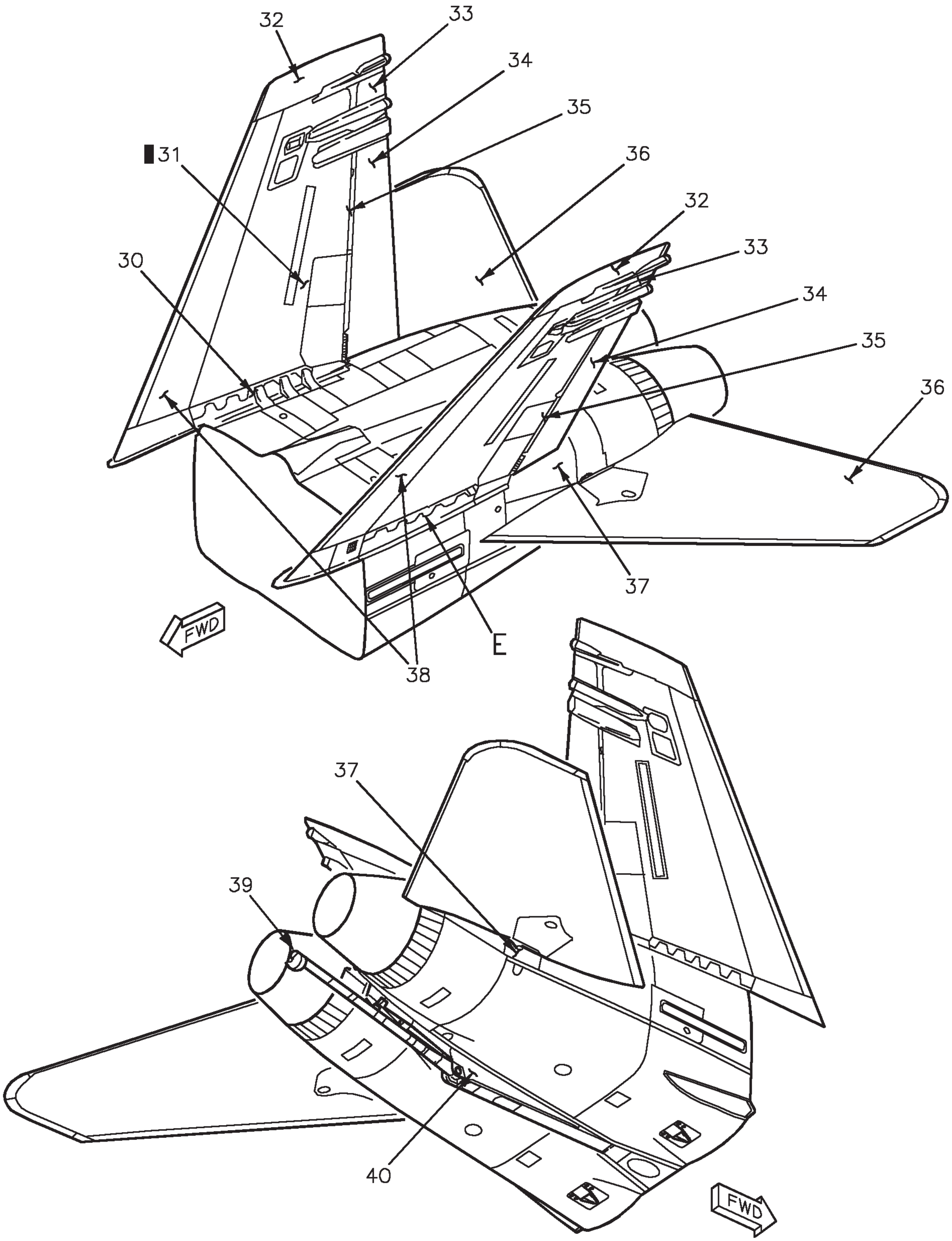


Figure 1. Nondestructive Inspection Index (Sheet 3)



AFT FUSELAGE/EMPENNAGE

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Figure 1. Nondestructive Inspection Index (Sheet 4)

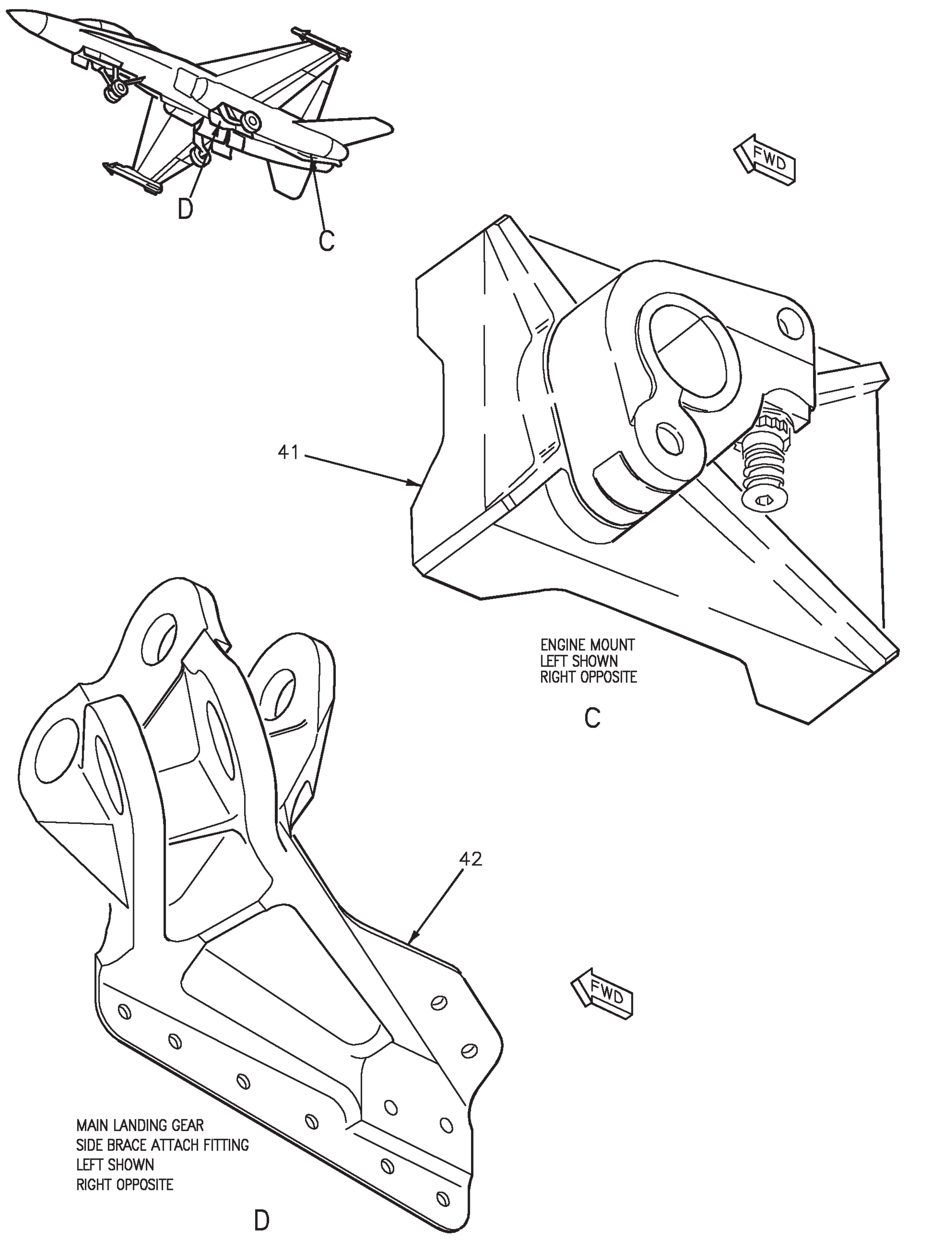

Figure 1. Nondestructive Inspection Index (Sheet 5)

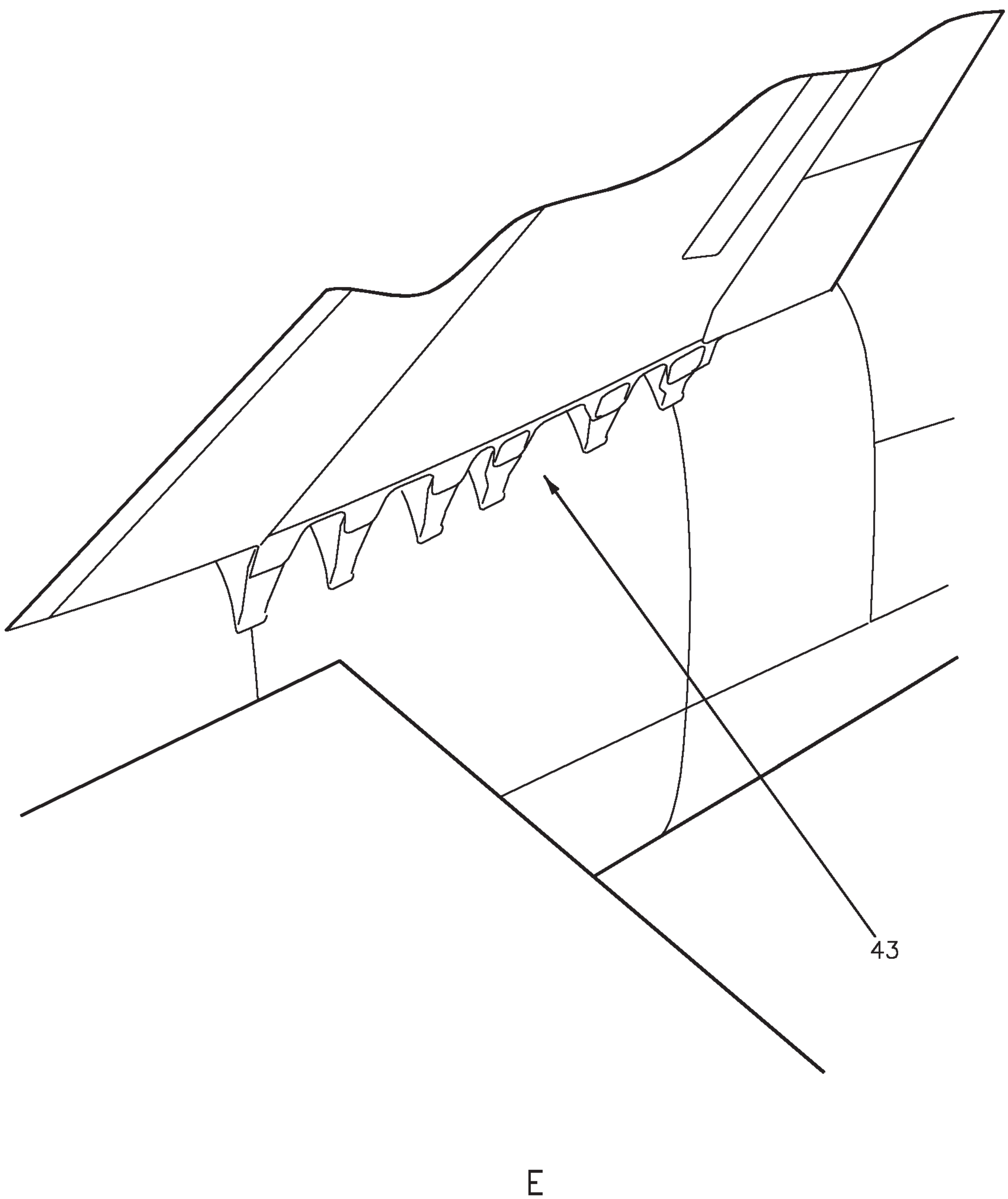

Figure 1. Nondestructive Inspection Index (Sheet 6)

INDEX NO.	NOMENCLATURE	WP NUMBER
1	INNER WING DRAG LOAD MEMBER FUSELAGE TO WING ATTACH HOLES FATIGUE CRACKS	021 02
	INNER WING LOWER SKIN ATTACH HOLES FATIGUE CRACKS	021 00
	INNER WING TO FUSELAGE UPPER AND LOWER ATTACH PIN ASSEMBLIES FATIGUE CRACKS	021 01
	INNER WING UPPER AND LOWER SURFACES COMPOSITE LAMINATE AND DOOR SILL INSPECTION AREAS	023 01
	INNER WING UPPER AND LOWER TITANIUM SPLICE FITTING AREAS SKIN TO TITANIUM SPLICE FITTING UNBONDS AND SKIN DELAMINATIONS	023 00
2	INNER WING ROOT UPPER AND LOWER ATTACH LUGS FATIGUE CRACKS	021 04
3	WING ROOT CLOSURE RIB, AFT SHEAR TIE BOX FLANGES FATIGUE CRACKS	021 03
4	INNER WING SKIN FIXED TRAILING EDGE PANELS AND ACCESS COVERS DELAMINATIONS	075 00
5	FLAP SHROUD WATER IN HONEYCOMB	015 00
6	TRAILING EDGE FLAP WATER IN HONEYCOMB	013 00
	TRAILING EDGE FLAP SKIN TO CORE UNBONDS AND DELAMINATIONS	014 00
	TRAILING EDGE FLAP OUTBOARD ROLLER SUPPORT FITTING	014 01
	TRAILING EDGE FLAP OUTBOARD HINGE	014 02
	TRAILING EDGE FLAP SHROUD HINGES	014 03
7	AILERON WATER IN HONEYCOMB	009 00
	AILERON OUTBOARD HINGE	009 02
8	AILERON SHROUD WATER IN HONEYCOMB	011 00
	AILERON SHROUD METAL TO METAL BONDLINE	012 00
9	OUTER WING TORQUE BOX SKIN DELAMINATIONS	024 00
	OUTER WING TORQUE BOX SKIN, WING FOLD RIB, AND MISSILE SUPPORT RIB AREAS, DELAMINATIONS	024 01
10	OUTBOARD FLAP WATER IN HONEYCOMB	019 00
11	INBOARD FLAP WATER IN HONEYCOMB	017 00
	ULTRASONIC RESONANCE INSPECTION FOR INBOARD LEADING EDGE FLAP SKIN-TO-AFT SPAR CAP BOND LINE	018 00
12	OUTER WING LOWER FIXED TRAILING EDGE PANEL DELAMINATIONS	072 00
13	AILERON DRIVE HINGE	009 01
14	OUTER WING LOWER SKIN TO FOLD RIB JOINT CRACKED OR BROKEN FASTENERS	024 02
15	CANOPY UNLATCH THRUSTER BRACKET SUPPORT	010 00
16	FORWARD AND CENTER FUSELAGE; UPPER BONDED HONEYCOMB DOORS SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	077 00

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Figure 1. Nondestructive Inspection Index (Sheet 7)

INDEX NO.	NOMENCLATURE	WP NUMBER
17	FORWARD FUSELAGE LOWER OUTBOARD, Y357.000, AND SIDE LONGERON, Y286.500, INSPECTION	073 01
18	FORWARD FUSELAGE BONDED HONEYCOMB CORE DOORS SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	073 00
	FORWARD FUSELAGE BONDED HONEYCOMB DOORS WATER IN HONEYCOMB	074 00
19	NOSE LANDING GEAR AFT DOOR WATER IN HONEYCOMB	079 00
	NOSE LANDING GEAR AFT DOOR SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	079 01
20	CENTER FUSELAGE Y526.000 TO Y534.000, LOWER OUTBOARD LONGERON AND SKIN INSPECTION	041 00
21	CENTER FUSELAGE BULKHEAD Y488.000, INNER WING LOWER LUG ATTACH POINT FATIGUE CRACKS	038 00
	CENTER FUSELAGE BULKHEAD Y488.000, INNER WING LOWER LUG ATTACH POINT; OUTBOARD, FATIGUE CRACKS	038 06
	CENTER FUSELAGE BULKHEAD Y488.000, CONTROL HOLE FATIGUE CRACKS	038 05
	CENTER FUSELAGE BULKHEAD Y488.000, FLANGE AND FLANGE/WEB RADII FATIGUE CRACKS	038 03
	CENTER FUSELAGE BULKHEAD Y488.000, FUEL PRESSURE LINE HOLE AREA FATIGUE CRACKS	038 02
	CENTER FUSELAGE BULKHEAD Y488.000, FUEL PRESSURE LINE HOLE AREA FATIGUE CRACKS AND UNBONDS	038 01
	CENTER FUSELAGE BULKHEAD Y488.000, HYDRAULIC LINE HOLE AREA FATIGUE CRACKS AND UNBONDS	038 04
22	CENTER FUSELAGE BULKHEAD Y470.500, CONTROL HOLE FATIGUE CRACKS	035 01
	CENTER FUSELAGE BULKHEAD Y470.500, INNER WING LOWER LUG ATTACH POINT FATIGUE CRACKS	035 00
	CENTER FUSELAGE BULKHEAD Y470.500, UPPER FLANGE STEP RADII FATIGUE CRACKS	035 02
23	CENTER FUSELAGE BULKHEAD 453.000, INNER WING LOWER LUG ATTACH POINT FATIGUE CRACKS	032 00
	CENTER FUSELAGE BULKHEAD Y453.000, UPPER FLANGE STEP AND TRANSITION RADII FATIGUE CRACKS	032 01
24	MAIN LANDING GEAR OUTBOARD DOOR SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	076 01
25	MAIN LANDING GEAR DOORS WATER IN HONEYCOMB	076 00
	MAIN LANDING GEAR DOOR SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	076 03
26	MAIN LANDING GEAR TRUNNION CRACKS	069 00
	MAIN LANDING GEAR TRUNNION LOWER SECTION CRACKS	069 01
	MAIN LANDING GEAR TRUNNION, LOWER SECTION CRACK VERIFICATION	069 02
	MAIN LANDING GEAR TRUNNION, OUTBOARD POST, CRACKS	069 06

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Figure 1. Nondestructive Inspection Index (Sheet 8)

INDEX NO.	NOMENCLATURE	WP NUMBER
27	MAIN LANDING GEAR AXLE LEVER ASSEMBLY CRACKS	069 03
	MAIN LANDING GEAR AXLE LEVER ASSEMBLY CRACK VERIFICATION	069 04
	MAIN LANDING GEAR AXLE LEVER WALL THICKNESS MEASUREMENT	069 08
28	RESIDUAL STRESS MEASUREMENTS FOR MAIN LANDING GEAR LEVERS	069 05
	MAIN LANDING GEAR AXLE FATIGUE CRACKS	068 00
	MAGNETIC PARTICILE INSPECTION OF THE MAIN LANDING GEAR AXLE IN THE POLYGON AREA	068 01
29	MAIN LANDING GEAR INBOARD DOOR SKIN TO CORE UNBONDS AND EDGE DELAMINATIONS	076 02
30	FORMERS AT Y590.500 AND Y598.00 FATIGUE CRACKS	059 02
	FORMERS AT 590.500 AND 598.000, IN STIFFENER AREA, FATIGUE CRACKS	059 03
31	VERTICAL STABILIZER SPARS AND RIBS FASTENER HOLE RADIOGRAPHY INSPECTION	060 00
	VERTICAL STABILIZER SPARS AND RIBS FASTENER HOLE EDDY CURRENT INSPECTION	060 01
32	VERTICAL STABILIZER TIP WATER IN HONEYCOMB	058 00
33	VERTICAL STABILIZER TRAILING EDGE ASSEMBLY COMPOSITE LAMINATE SKIN TO TITANIUM CLOSURE, UNBONDS; AND COMPOSITE LAMINATE SKIN DELAMINATIONS	059 01
	VERTICAL STABILIZER TRAILING EDGE WATER IN HONEYCOMB	059 00
34	RUDDER WATER IN HONEYCOMB	061 00
	RUDDER SKIN TO CORE AND TRAILING EDGE CLOSURE UNBONDS,AND SKIN DELAMINATIONS	062 00
35	VERTICAL STABILIZER 77.5 PERCENT SPAR WEB TOOLING HOLE CRACKS	059 04
36	HORIZONTAL STABILATOR WATER IN HONEYCOMB	053 00
	HORIZONTAL STABILATOR METAL TO METAL BONDLINE	054 00
	HORIZONTAL STABILATOR SKIN TO CORE UNBONDS AND SKIN DELAMINATIONS/SKIN TO CLOSURE UNBONDS AND SKIN DELAMINATIONS	055 00
	HORIZONTAL STABILATOR BALLAST AREA	055 01
	HORIZONTAL STABILATOR SKIN TO CORE UNBONDS AND SKIN DELAMINATIONS/SKIN TO CLOSURE UNBONDS AND SKIN DELAMINATIONS	055 02
	HORIZONTAL STABILATOR OUTBOARD AFT CORE SPLICE AREA	055 03
	HORIZONTAL STABILATOR OUTBOARD AFT CORE SPLICE AND BALLAST AREA	055 04
	INSPECTION OF GRAPHITE EPOXY SKIN FOR DELAMINATIONS AT LEADING EDGE OF HORIZONAL STABILATOR	055 05
37	HORIZONTAL STABILATOR SPINDLE FATIGUE CRACKS	042 00
	HORIZONTAL STABILATOR STRUCTURAL SUPPORT FATIGUE CRACKS	043 00

ADA792-1-9-041

Figure 1. Nondestructive Inspection Index (Sheet 9)

INDEX NO.	NOMENCLATURE	WP NUMBER
38	VERTICAL STABILATOR LEADING EDGE WATER IN HONEYCOMB	057 00
	VERTICAL STABILATOR LEADING EDGE SKIN TO CORE UNBONDS, SKIN DELAMINATIONS, AND TITANIUM SKIN TO COMPOSITE SKIN UNBONDS	084 00
39	ARRESTING HOOK HOLLOW PIN CRACKS	070 01
	ARRESTING HOOK SHANK, HOOK POINT SUPPORT AREA FATIGUE CRACKS	071 00
40	ARRESTING HOOK SUPPORT FATIGUE CRACKS	070 00
41	ENGINE; INBOARD THRUST MOUNT FATIGUE CRACKS	045 00
42	MAIN LANDING GEAR SIDE BRACE ATTACH FITTING CRACKS	069 07
43	VERTICAL STABILIZER; OUTBOARD FACE OF OUTBOARD FORMER ON Y590.500 AND Y598.000 FORMERS	059 05

ADA792-1-10-041

Figure 1. Nondestructive Inspection Index (Sheet 10)

INTRODUCTION

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

This WP supersedes WP002 00, dated 1 December 1992.

1. PURPOSE.

2. This manual provides nondestructive inspection procedures for organizational, intermediate, and depot levels of maintenance. Inspections shall be identified as organizational, intermediate, or depot level inspections within each specific procedure work package.

3. REQUISITION AND AUTOMATIC DISTRIBUTION OF NAVAIR TECHNICAL MANUALS.

4. Procedures to be used by Naval activities and other Department of Defense activities requiring NAVAIR technical manuals are defined in NAVAIR 00-25-100 and NAVAIRINST 5605.5.4A.

5. To automatically receive future changes and revisions to NAVAIR technical manuals, an activity must be established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Data and Engineering Service Command (NATEC). To become established on the ADRL, contact your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution by contacting the Commanding Officer, NATEC, Attn: Distribution, NAS North Island, Bldg. 90, P.O. Box 357031, San Diego CA 92135-7031. Reconfirmation of these requirements is required once a year to remain on automatic distribution. Please use your NATEC assigned account number when referring to automatic distribution requirements.

6. If more or replacement copies of this manual are required with no attendant changes in the ADRL, they may be ordered by submitting a MILSTRIP requisition in accordance with NAVSUP 485 to Routing Identifier Code ″NFZ″. MILSTRIP requisitions can be submitted through your supply office, Navy message, or SALTS to DAAS (Defense Automated Address System), or through the DAAS or NAVSUP web sites. For assistance with a MILSTRIP requisition, contact the Naval Inventory Control Point (NAVICP) Publications and Forms Customer Service at Defense Switched Network 442-2626 or (215) 697-2626, Monday through Friday, 0700 to 1600 Eastern Time.

7. TRAINING AND QUALIFICATION REQUIREMENTS.

8. The minimum requirements for training and qualification of nondestructive inspection personnel are defined in OPNAVINST 4790.2 SERIES.

9. MANUAL ISSUE DATE.

10. The date on the title page is the copy freeze date. No additions, deletions or changes are made after the manual issue date, except last minute safety of flight or required maintenance changes. Data collected after the manual issue date will be included in later changes or revisions of the manual.

11. AIRCRAFT DESCRIPTION.

12. The F/A-18A/C is a single place fighter/attack aircraft, the F/A-18B/D is a two place version of the F/A-18A/C. They are powered by two F404-GE-400 turbofan engines with afterburner. The aircraft have a variable camber mid wing with leading edge extensions. The two vertical stabilizers are angled outboard 20° from vertical. The wings have hydraulically actuated leading and trailing edge flaps and ailerons. Rudders and stabilators are also hydraulically controlled. The airframe is primarily made of aluminum. Graphite epoxy composite compound is used for many skins and doors. Titanium is also used for skins and doors. Where maximum strength is required, beta annealed bar, plate, and forgings are used. High strength steel is

used in landing and arresting gear. Hydraulic tube assemblies are titanium.

13. **EFFECTIVITIES.**

14. Effectivity notes on manual title pages, work package title pages, and within a work package indicate the aircraft to which the data applies. If no effectivity note appears on the work package title page, the work package has the same effectivity as shown on the manual title page. The effectivity notes may use:

a. Type, model, and series

NOTE

F/A-18D aircraft after bureau number 164967 was referred to as bureau number F/A-18D D-140. Now, F/A-18D aircraft after bureau number 164967 is 165409.

b. Bureau number (tail number)

c. Combination of type, model series, and bureau numbers

d. Part number or serial number

e. Technical directive number

The table below shows examples of effectivity notes and their meanings:

Effectivity Note Examples

Effectivity Note	Definition
161362 AND UP	Applicable to all F/A-18A, F/A-18B, F/A-18C and F/A-18D for bureau numbers listed.
F/A-18A, F/A-18B	Applicable to all F/A-18A and F/A-18B.
F/A-18C, F/A-18D	Applicable to all F/A-18C and F/A-18D.
F/A-18A	Applicable to all F/A-18A, but not F/A-18B, F/A-18C and F/A-18D.
F/A-18B	Applicable to all F/A-18B, but not F/A-18A, F/A-18C, and F/A-18D.
F/A-18C	Applicable to all F/A-18C, but not F/A-18A, F/A-18B, and F/A-18D.
F/A-18D	Applicable to all F/A-18D, but not F/A-18A, F/A-18B, and F/A-18C.
F/A-18A, F/A-18C	Applicable to all F/A-18A and F/A-18C, but not to F/A-18B and F/A-18D.
F/A-18B, F/A-18D	Applicable to all F/A-18B and F/A-18D, but not to F/A-18A and F/A-18C.

Effectivity Note Examples (Continued)

Effectivity Note	Definition
F/A-18A 161353, 161359 THRU 161364	Only applicable to some bureau numbers of F/A-18A. Not applicable to any F/A-18B, even if a F/A-18B bureau number is within the numbers listed.
F/A-18C 163427, 163449 THRU 163456	Only applicable to some bureau numbers of F/A-18C. Not applicable to any F/A-18D, even if a F/A-18D bureau number is within the numbers listed.
F/A-18B 161354 AND UP	Only applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed.
F/A-18D 163434 AND UP	Only applicable to some bureau numbers of F/A-18D. Not applicable to any F/A-18C, even if a F/A-18C bureau number is within the numbers listed.
161353 THRU 161356 BEFORE F18 AFC 772; AND F/A-18C AND F/A-18D	Applicable to F/A-18A and F/A-18B for bureau numbers listed, before modification by technical directive.
161357 AND UP, ALSO 161353 THRU 161356 AFTER F18 AFC 772; AND F/A-18C AND F/A-18D	Applicable to aircraft modified during production; also applicable when affected aircraft have been modified by technical directive.
P/N 74A210001-1001, 74A210001-1003, AND 74A210001-1005	Applicable to assemblies which are interchangeable between aircraft.
Outer Wing Assembly Serial Number A13-0022	Applicable to assemblies which are interchangeable between aircraft, but configurations can not be identified by part number.

15. TECHNICAL DIRECTIVES.

16. Technical directives are documents which provide instructions to add and record retrofit configuration modification or inspection instructions to delivered aircraft, or aircraft components.

17. **AIRFRAME CHANGE (AFC) AND AIRBORNE TACTICAL SOFTWARE CHANGE (ASC) .** Technical directives which change configuration of aircraft structure or equipment installation, i. e. AFC, will list aircraft bureau numbers in effectivity notes and show before and after the AFC. Technical directives which change configuration of operational flight programs (OFP), i. e. ASC, will list the OFP CONFIG/IDENT NUMBER in effectivity notes and show the latest two authorized OFP programs. See AFC and ASC effectivity examples in Effectivity Note Example Table.

18. **AIRCRAFT COMPONENT CHANGES.** Technical directives which change configuration of aircraft components are listed below:

AAC	Aviation Armament Change for armament equipment
ACC	Aircrew System Change for aircrew survival equipment
AFC	Airframe Change for aircraft structure and equipment
ASC	Airborne Software Change for operational flight programs
AVC	Avionics Change for airborne electronic equipment, including wiring changes
AYC	Accessory Change for mechanical system
PPC	Power Plant Change for engines

19. Component changes will list part numbers in the effectivities. See AVC effectivity examples in Effectivity Note Example table.

20. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

21. The technical directives affecting this manual are listed in the Record of Applicable Technical Directives of each affected work package. Because an ASC directs all aircraft be modified within 30 days, ACS's are not listed. When all affected aircraft are modified, the before configuration is removed from the manual, and the technical directive entry is removed from the Record of Applicable Technical Directives.

22. NONDESTRUCTIVE INSPECTION METHODS.

23. Nondestructive inspection (NDI) methods are those methods which may be applied to structure, part, or material to determine its integrity without causing change in any of its physical characteristics. These methods include:

a. Eddy Current Method. Eddy current inspection is a nondestructive method for getting information on a number of material variables such as alloy type, hardness, heat treat condition, thickness, and defects. Eddy currents are electrical currents induced into a conductor of electricity by reaction with a magnetic field. The eddy currents are circular and their paths are oriented perpendicular to direction of applied magnetic field.

b. Magnetic Particle Method. Magnetic particle inspection is effective in detection of surface and near surface defects in ferromagnetic parts. The inspection is done by inducing a magnetic field into the part and applying liquid inspection material of iron particles or dry magnetic powder to surface to be inspected. Local magnetic fields formed by defects in the part attract magnetic particles, producing visible indications by color contrast or by fluorescence under black light.

c. Penetrant Method. Penetrant inspection is a nondestructive test for discontinuities open to the surface in parts made of nonporous materials. This is done by treating the surface area with a fluid which penetrates into surface discontinuity. Excess penetrant not in the discontinuity is removed and penetrant remaining in the discontinuity is returned to the surface by capillary action. A developer is applied to provide a contrasting surface, and through absorption forms an indication large enough to be visible.

d. Radiographic Method. Radiographic inspection is a nondestructive inspection method using a source of X-rays or gamma rays to detect discontinuities in materials and components. X-rays penetrate metallics and nonmetallics and are differentially absorbed, allowing radiography to be used on both metallic and nonmetallic materials.

e. Ultrasonic Method. Ultrasonic inspection is a method of inspection using sound waves with frequencies that are above audible range. High frequency sound is induced into the part by a transducer. As this ultrasonic energy travels through the part, any variations in acoustic properties will reflect sound back to the transducer. This information is then displayed on a oscilloscope, cathode ray tube (CRT).

24. HOW TO USE THE MANUAL.

25. Text and illustrations contained in this manual are in work package format. These work packages are complete sets of data or procedures arranged in a logical sequence supplying instructions, references, and material/equipment requirements for doing each inspection. Work package types contained in this manual are listed in steps a through g below:

a. Alphabetical Index Work Package. This work package contains an alphabetical listing, by title, of each work package contained within the manual. This work package is numbered 001 00.

b. Work Package Index. This work package contains a numeric listing and the title of all work packages in the manual. This work package is numbered 001 01.

c. Nondestructive Inspection Index Work Package. This work package contains illustration(s) which index location of nondestructive inspection data for each structural group and component covered. It contains a table(s) listing item, nomenclature, work package number, and search number for location within the manual. This work package is numbered 001 02.

d. Introduction Work Package. This work package contains introductory information for the nondestructive inspection technician's use. This work package is numbered 002 00.

e. General Information Work Package. General information related to nondestructive inspection of aircraft structure and structural components is included. This work package is numbered 003 00.

f. Numerical Index of Effective Work Packages/Pages. This index (A Page) provides the user with current status of the publication.

g. Technical Publication Deficiency Report (TPDR) Work Package. This work package lists deficiency reports incorporated into a specific manual during changes/revisions. This work package is numbered TPDR-1.

h. Typical Procedure Work Packages. Typical procedure work packages are those which contain information applicable to more than one structural group or component. This avoids duplication of information and is referenced as needed from specific procedure work packages. An example of a typical procedure work package is 008 00.

i. Specific Procedure Work Packages. Specific procedure work packages are those which provide a primary inspection procedure and, if required, a backup inspection procedure for a specific structural group or component. The item to be inspected is identified by nomenclature, physical description, and description of suspected defect.

26. WARNINGS, CAUTIONS, AND NOTES.

27. Items of special importance and critical information are identified in warnings, cautions, and notes. Warnings and cautions appear immediately, before the step to which they apply. Notes may appear before or after the affected step.

WARNING

Warnings describe conditions or procedures that could result in injury or death if correct procedures are not followed.

CAUTION

Cautions describe conditions or procedures that could result in damage to or destruction of equipment if correct procedures are not followed.

NOTE

Notes describe or clarify conditions or procedures.

28. SAFETY PRECAUTIONS.

29. General safety precautions applicable to nondestructive inspection methods are contained in NAVAIR 01-1A-16. Additional safety precautions are contained in specific and typical procedure work packages as needed.

30. GLOSSARY OF TERMS.

31. This glossary contains definitions for commonly used NDI methods plus terms of a general nature which may be applicable:

a. ION VAPOR DEPOSITION ALUMINUM (IVD) - Application of coating with high purity aluminum on ferrous and nonferrous metals for a corrosion prevention or protective finish.

b. YOKE (PROBE) - Hand held electromagnet which supplies a longitudinal magnetic field between legs when placed on part and energized.

c. TRUE CONTINUOUS METHOD - Magnetic particle inspection method, primarily used when inspecting with yoke (probe). Inspection material is applied to part and inspection is done while magnetizing current is on.

d. DELAMINATION - Separation between plies of a laminated part.

e. UNBOND - Separation of skin to core, skin to skin, or skin to closure bond.

f. BOND SEPARATION - Separation of core to structure bond.

g. STEP AREA UNBOND - Separation of bond between composite and metallic portions of bonded skin assemblies.

h. METAL TO METAL UNBOND - Separation of bond between two metal pieces.

i. ALPHA CASE - Hard brittle layer of surface oxidation on titanium. This condition will appear as a dull nonreflective oxide. Bright colors ranging from yellow through red to dark blue are thinner layers of oxide than alpha case and are good.

32. NONDESTRUCTIVE INSPECTION SYMBOLS.

33. Symbols that may be used on inspection figures are shown in figure 1.

34. TECHNICAL PUBLICATION DEFICIENCY REPORTS (TPDR).

35. The TPDR (OPNAV FORM 4790/66) is the form for reporting errors and suspected omissions in the technical manuals. The TPDR WP lists the TPDRs that are included in the current issue of the manual.

36. TPDR reporting procedures are in OPNAVINST 4790.2 SERIES.

37. QUALITY ASSURANCE PROCEDURES.

38. Procedures or parts of procedures which require quality assurance inspection are identified by the letters (QA) after the applicable steps. When (QA) is assigned to a step or a heading which is immediately followed by substeps, the inspection requirement is applicable to all substeps.

39. When doing maintenance in any area, a visual inspection of the area will be made for cracks, corrosion, and security of component installation before securing the area for flight.

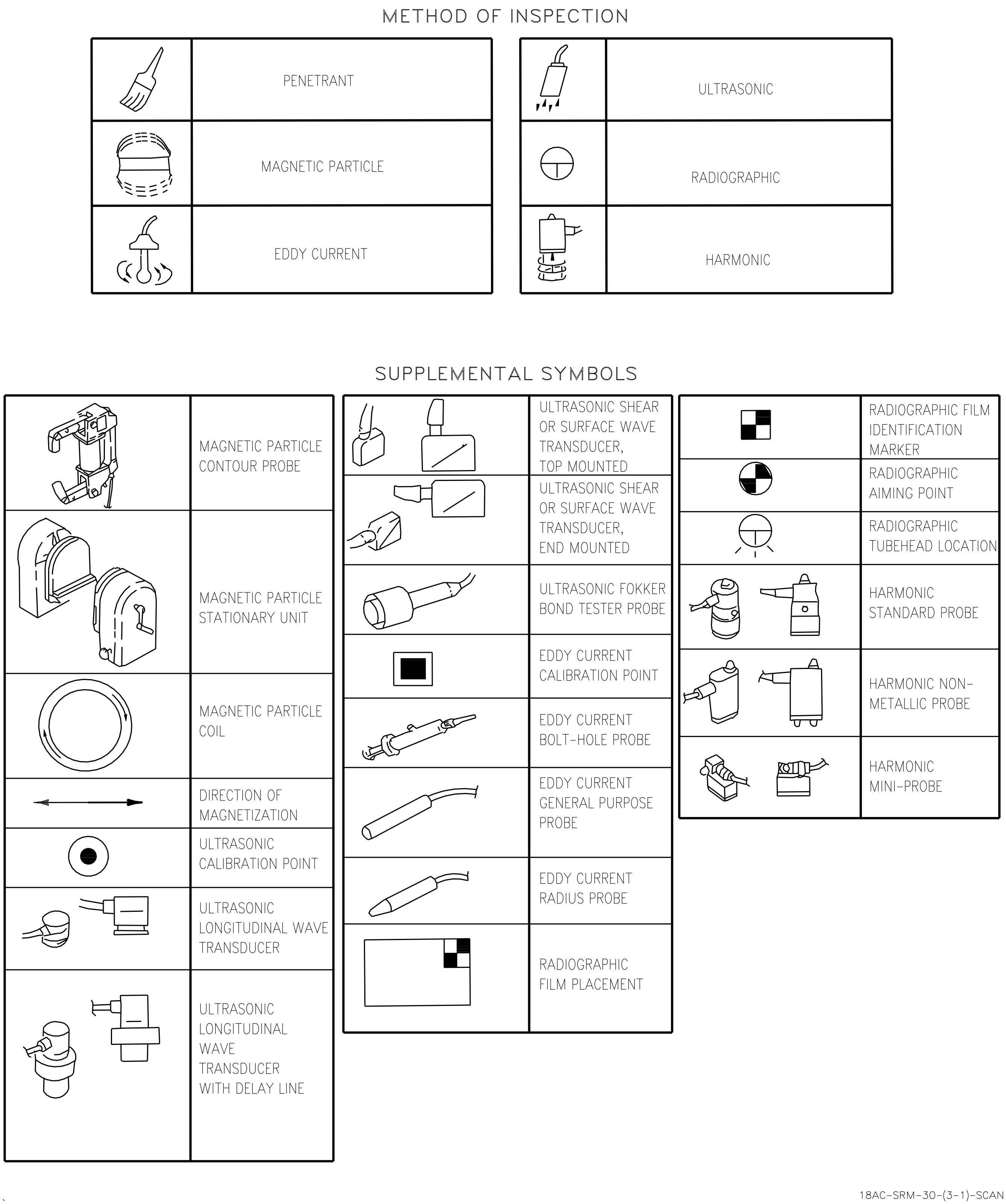
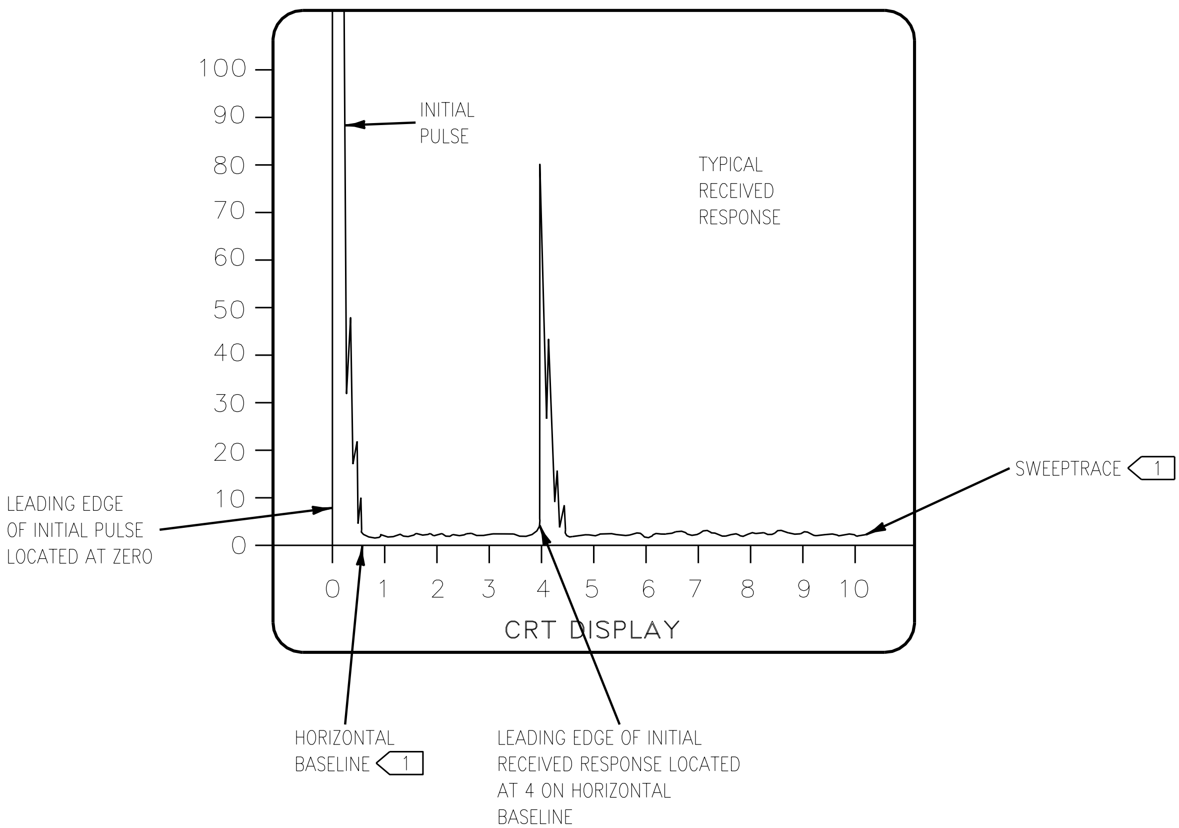


Figure 1. Nondestructive Inspection Symbols (Sheet 1)



TYPICAL CRT DISPLAY

LEGEND

1 HORIZONTAL BASELINE IS COINCIDENT WITH SWEEPTRACE. SWEEPTRACE HAS BEEN RAISED FOR ILLUSTRATION USE ONLY.

18AC-SRM-30-(3-2)-CATI

Figure 1. Nondestructive Inspection Symbols (Sheet 2)

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

GENERAL INFORMATION

Reference Material

Daily/Special/Preservation Maintenance Requirements Cards	A1-F18AC-MRC-200
Daily/Special/Preservation Maintenance Requirements Cards	A1-F18AE-MRC-200

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. This work package contains information related to nondestructive inspection of aircraft structure and structural components. Nondestructive inspection personnel should be familiar with this information because some is not repeated or referenced in typical or specific procedure work packages. For example, frequency of nondestructive inspections.

3. **FREQUENCY OF NONDESTRUCTIVE INSPECTION.** Established inspection frequency for aircraft structure or structural components is contained in (A1-F18AC-MRC-200 or A1-F18AE-MRC-200).

4. **EXAMPLES OF DEFECTS.** See figure 1. Defects that may develop in laminates and bonded honeycomb assemblies, are shown to aid nondestructive inspection personnel in definition of suspected defects identified in specific procedure work packages.

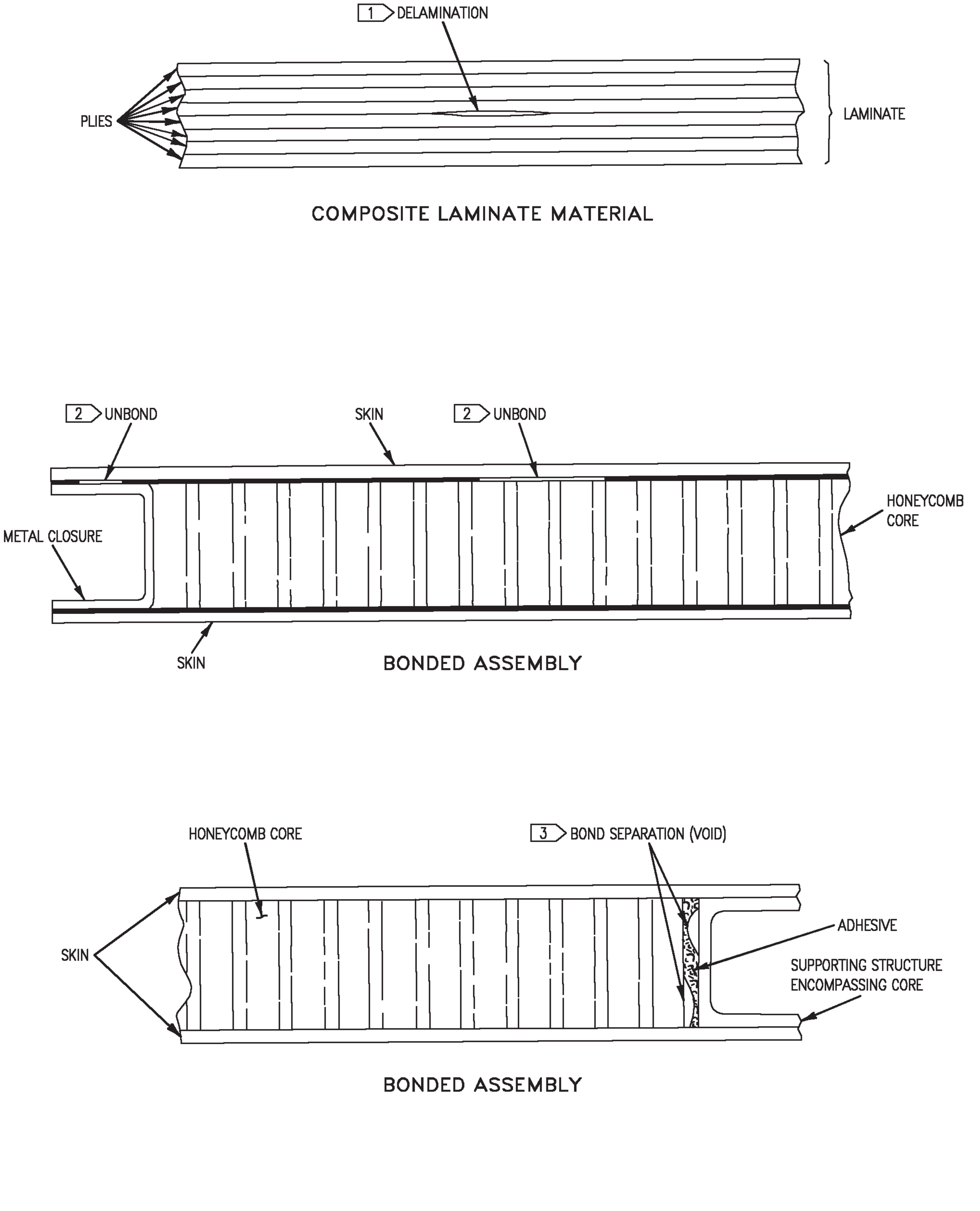
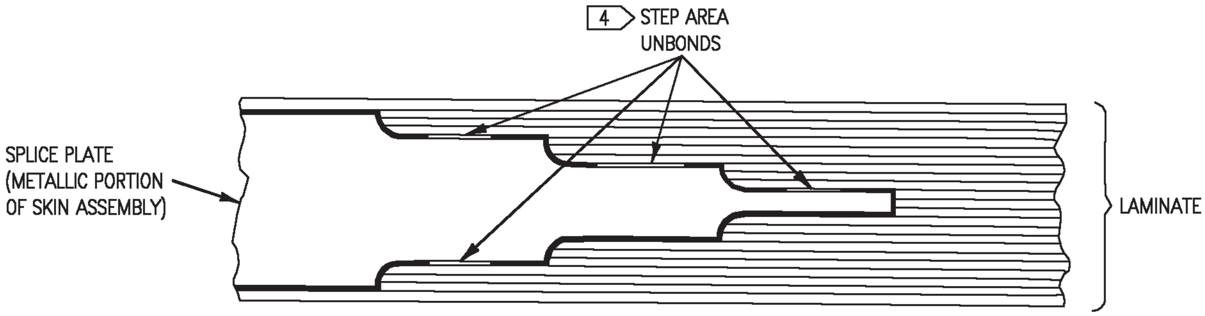
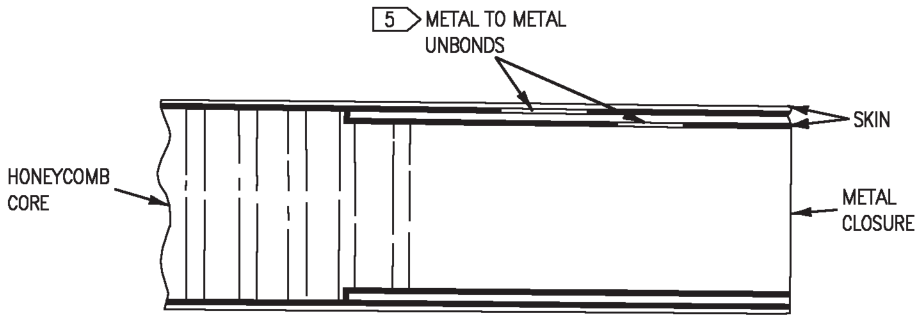


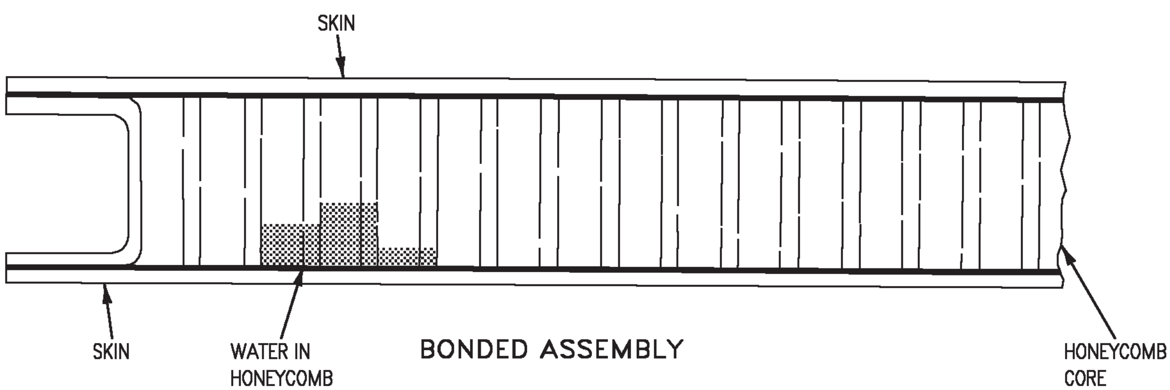
Figure 1. Examples of Defects That May Develop in Laminates and Bonded Honeycomb Assemblies (Sheet 1)



BONDED SKIN ASSEMBLY



BONDED ASSEMBLY



BONDED ASSEMBLY

LEGEND

1 DELAMINATION: SEPARATION BETWEEN PLIES OF A LAMINATED PART.

2 UNBOND: SEPARATION OF SKIN TO CORE, SKIN TO SKIN, OR SKIN TO CLOSURE BOND.

3 BOND SEPARATION: SEPARATION OF CORE TO STRUCTURE BOND.

4 STEP AREA UNBOND: SEPARATION OF BOND BETWEEN COMPOSITE AND METALLIC PORTIONS OF BONDED SKIN ASSEMBLIES.

5 METAL TO METAL UNBOND: SEPARATION OF BOND BETWEEN TWO METAL PIECES.

18AC-SRM-30-(4-2)34-SCAN

Figure 1. Examples of Defects That May Develop in Laminates and Bonded Honeycomb Assemblies (Sheet 2)

ORGANIZATIONAL MAINTENANCE

NONDESTRUCTIVE INSPECTION

PENETRANT METHOD

This WP supersedes WP004 00, dated 1 December 1992.

Reference Material

Nondestructive Inspection Methods	NAVAIR 01-1A-16
Plane Captain Manual	A1-F18AC-PCM-000
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Military Specification, Inspection Materials, Penetrant	MIL-I-25135

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Penetrant inspection is nondestructive inspection for discontinuities open to surface in parts made of nonporous materials. This is done by treating surface area with fluid which penetrates surface discontinuity. Excess penetrant not in discontinuity is removed and penetrant remaining in discontinuity returns to surface by capillary action. Developer is applied to provide contrasting surface, and through absorption forms indication large enough to be visible to eye. Visual indications become distinct by fluorescence of penetrant under black light. This method is effective for detecting defects open to surface in forgings, castings, extrusions, formed sections, webs, and skins of ferrous or nonferrous material. Penetrant method of inspection requires surface inspection area be thoroughly cleaned and stripped of paint or other surface coatings, for example, dry film lubricant.

3. SAFETY PRECAUTIONS.

a. Make sure safety requirements have been met before using electrical equipment near aircraft fuel cells, oxygen systems, and stores (A1-F18AC-PCM-000).

b. Refer to (NAVAIR 01-1A-16) for other safety precautions to be followed when doing penetrant inspection.

4. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
(M-16)	Black Light Capable of 1000MW Over 6 Inch Circle 15 Inches from Bulb Face
J-221	Ultraviolet Meter

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-I-25135 QPL-25135-15	Penetrant, Type 1, (Fluorescent), Method C, Solvent Removable), Sensitivity Level 2 or 3, Class 2, Solvent Remover (Non-halogenated) and Nonaqueous Developer

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

123 Cleaner	Cleaning Compound
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
673T	Tube Type Marker

5. **LIGHTING REQUIREMENTS.**

a. In inspection booth, white light shall be less than 2 foot-candles and black light intensity shall be at least 1000 micro-watts at surface of part. When checking background white light intensity, black light must be turned off or removed from inspection area.

b. For on-aircraft inspections, surface under inspection must be heavily shaded, and black light shall be held close as possible to ensure bright indication. To inspect lighting adequacy, use pin or other sharp object to draw thin line of penetrant on part near inspection area. This line should be bright and distinct.

6. **PREPARATION OF PART.**

CAUTION

Do not do prepenetrant etching on steel parts. Acid used for etching can cause embrittlement or corrosion of critical structure.

a. Part must have finish system removed before inspection. Refer to specific procedure work package for details. If specific procedure work package does not exist, chemically remove finish system (A1-F18AC-SRM-500, WP007 00).

WARNING

123 cleaning compound is an irritant to skin and eyes. Skin and eye protection are required. Avoid repeated or prolonged contact.

020X413 cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

c. Allow to air dry for 15 minutes after cleaning.

7. **INSPECTION PROCEDURE.**

CAUTION

Abrasive removal of material by grinding, sanding, or polishing at crack area will cause metal to be smeared in surface of crack resulting in hidden flaws. If inspection surface has been mechanically worked before inspection but after most recent aircraft flight, penetrant inspection shall not normally be done unless surface is etched to remove smeared metal. Etching shall not be done without depot engineering disposition.

a. Do Fluorescent Penetrant Inspection (NAVAIR 01-1A-16). Penetrant materials shall conform to MIL-I-25135. See specific work package for type, method, and sensitivity level. If specific work package does not exist, or materials are not specified, use type I, Method A, sensitivity level 2 or 3. Penetrant designated in latest revision to qualified products list of MIL-I-25135.

b. Apply penetrant to area to be inspected by spraying, brushing, or wiping.

c. Allow penetrant to dwell for time listed below:

8. **Penetrant Dwell Time**

Part or Ambient Air Temperature	Time
Above 120 °F	Do not inspect
100 - 120 °F	15 minutes
60 - 100 °F	30 minutes
40 - 60 °F	60 minutes
Below 40 °F	Do not inspect

WARNING

123 cleaning compound is an irritant to skin and eyes. Skin and eye protection are required. Avoid repeated or prolonged contact.

020X413 cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Remove penetrant with non-halogenated solvent recommended by penetrant manufacturer or with cleaning compound moistened cloth.

b. Allow to air dry for 15 minutes after cleaning.

c. Apply Form D nonaqueous developer.

9. **INTERPRETATION.**

a. Initial interpretation shall be immediately after developer has dried. Allow developer to dwell for minimum of 5 minutes but not more than 30 minutes before making final interpretation.

b. Interpretation shall be done with naked eye unless specific procedure work package instructs use of magnification.

c. Mark all linear indications detected. Linear indications are defined as those having length: width ratio greater than or equal to 3:1. Rounded indications shall not be cause for evaluation unless stated in specific procedure work package or unless rounded indications form line that could indicated partially closed crack.

10. **ACCEPTANCE LIMITS.**

a. Evaluation of all indications shall be done using acceptance limits for inspection area listed in specific procedure work package. If this information is not included in specific procedure work package, refer to structural repair manual (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) damage limits for specific inspection area.

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

RADIOGRAPHIC METHOD

Reference Material

Nondestructive Inspection Methods	NAVAIR 01-1A-16
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. **DESCRIPTION.**

2. Radiographic is nondestructive inspection method using source of x-rays to detect discontinuities in materials and assembly components. X-rays penetrate materials and are differentially absorbed. Discontinuities, less dense than surrounding material absorb less radiation, and are shown on radiographic film recording medium as darker areas when compared to nearby images. Discontinuities, more dense than surrounding areas, absorb more radiation and are shown as lighter areas when compared to nearby images. Recording medium, is usually film, but it can be any device that converts x-ray radiation into visible images. Radiography may be used on metallic, nonmetallic, and combination metallic/nonmetallic materials and assemblies without access to interior. However, defects must be correctly aligned and oriented with respect to penetrating rays to be reliably detected. Radiography is one of the most expensive and least sensitive methods for crack detection. It should only be used to detect flaws that are not accessible or favorably oriented for use of other test methods. Many variations in equipment output with respect to numerical settings, and trained NDI technicians should be qualified to compensate for these variations.

3. **GENERAL INFORMATION.** In radiographic inspections contained in specific procedure work packages, exposures are treated individually. One or more pieces of film may be used in each exposure. Films may or may not be double loaded. Information included in each specific procedure work package and terms are listed below:

a. Equipment required

b. Materials required

c. Description of part to be x-rayed

d. Defect description

e. Preparation of aircraft

f. Preparation of part

g. Film location, size, and group

h. Location of penetrameters, screens, and film identification markers

i. Target point, tube head position, and distance of x-ray source to aiming point in inches

j. Milliamperes (mA)

k. Kilovoltage peak (kVP)

l. Exposure time in minutes

m. Approximate film density in Hunter and Driffield units (H and D units)

4. **SAFETY PRECAUTIONS.**

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

a. Make sure safety requirements for electrical, static, grounding when using radiographic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores have been met (A1-F18AC-PCM-000).

b. Make sure safety requirements have been met for protecting operator and nearby personnel from x-ray radiation.

5. **Effect of X-radiation on Electronic Components.** Amount of radiation from typical x-ray source used for nondestructive inspections is approximately 80 roentgen. This radiation is attenuated and scattered by overlying skins and target before it strikes upon electronic components. It should be noted electronic components generally are not close, within several feet, to radiographic inspection items listed in this manual. Intensity of radiation is further reduced by inverse square law considerations. Based on literature surveyed, see references below, x-radiation amounts near 10,000 roentgen are required to effect changes in most electronic component materials. After several applications of NDI radiographic procedures, safety factor of approximately 1000 remains.

a. References:

(1) Space-Radiation Effects on Electrical Insulation and Semiconductors by J. F. Weller, F. J. Campbell, and J. W. Kallander, Electro-Technology, Feb. 1962.

(2) Radiation Stability of C. D. Bopp and O. Sisman; Nucleonics, July 1955.

(3) Radiation Damage in Solids by Billington and Crawford, Princeton University Press, 1961.

(4) Interaction of Radiation With Solids, Adli Bishay-Editor, Proceedings of Cairo Solid State Conference, Plenum Press, N.Y., N.Y., 1967.

NOTE

Positive prints of radiographs are used in figures 1, 2, and 3 of this WP. Dark areas of radiograph will appear as light areas on positive print and light areas on radiograph will appear as dark areas on positive print.

6. **INTERPRETING RADIOGRAPHS FOR WATER TRAPPED IN HONEYCOMB.** See figure 1 for radiograph reproduction of honeycomb assembly with water trapped in core.

7. **INTERPRETING RADIOGRAPHS FOR ADHESIVE SEPARATION.** See figure 2 for radiograph reproduction of adhesive separation and figure 3 for internal rib adhesive bond. Image of adhesive in radiographs of bonded assemblies is significantly lighter than nearby areas, linear in direction, and usually 1/16 to 1/4-inch wide, located at core splices, closures, shear ties, and at fasteners having no accessible heads. When interpreting radiographs look for cracks in adhesive, separation of core from

adhesive, or separation of adhesive from closure web or shear ties.

8. **EXPOSURE VALUES.**

a. Even though specific procedure work packages in this manual give all required exposure information to do inspection, exposure parameters may require adjustment because of equipment variations or type of inspection. Nonuniformities in x-ray tube line voltage may require technician compensation in exposure parameter to get correct film density. Some assemblies contain extra layers of film and foaming adhesive which are not externally visible. Film density compensation may be needed in these areas.

b. When film density in area of interest is lower than required, change exposure parameters in order listed below:

(1) Increase exposure time.

(2) Increase filament current.

(3) Increase kilovoltage.

c. When film density in area of interest is higher than required, change exposure parameters in the order listed below:

(1) Decrease exposure time.

(2) Decrease filament current.

(3) Decrease kilovoltage.

d. Never change focal spot in film distance (FFD) or source to film distance (SFD) to compensate for changes in film density unless these parameter changes do not affect inspection outcome. Changing FFD or SFD establishes new geometric unsharpness (Ug) parameter. Large geometric unsharpness produces fuzzy image or image with undefined edges. Edges are not out of focus, but are being imaged onto film plane by more than point source. When expected defect size is approximately equal to or less than unsharpness parameter, reliable flaw detectability is decreased. Geometric unsharpness is defined as below:

$Ug = ft \div d$

Ug = geometric unsharpness.

t = thickness in inches of object being radiographed or distance of area of interest above film. If film is not in contact with object being tested then it is the sum of object thickness and distance between object and film.

f = effective source (focal spot) size as measured Methods of Evaluating Radiological Equipment and Materials.

d = minimum distance from x-ray source to object being radiographed.

Make sure units of Ug, t, f, and d are consistent. Example; all inches or all millimeters.

9. **TYPES OF HONEYCOMB CORE DAMAGE.** See figure 4.

10. **Water Entrapment.** See figure 1. Water or liquid type intrusion into an assembly may be harmful to structural integrity of part. Water which has entered part by way of open edge migration or capillary action and internally condensed at 70°F, may freeze and expand at altitudes where temperature is below 32°F. At higher temperatures this condensed water may vaporize to create abnormally high pressures and damage honeycomb core.

a. Water is usually found entrapped in bonded honeycomb assemblies in two or more cells next to each other. Since water is excess or added material for x-rays to penetrate, water images on radiograph fill will appear light when compared to images of nearby cells which are void of water. The image film density will depend on amount of water in the cell. Radiographically a water image appears as a very uniform density across the honeycomb cell.

b. Water images appear similar to areas where extra adhesive has been added for tie in or build up area. Normally, isolated cells which contain extra adhesive or fill material will also contain small gas bubbles which envolved during cure. The radiographic image of these extra adhesive layers will contain porosity indications.

c. Differentiate entrapped water from extra adhesive by looking for these porosity indications.

d. Water entrapment inspection procedures are established to detect water as quickly and efficiently as possible. Because of this, it is desirable to radiograph large areas. Large areas are best inspected when FFD or SFD is maximized. These

large distances make sure as much honeycomb core as possible is correctly aligned with central ray of x-ray beam. It is possible to decrease FFD to compensate for parameter changes, but this reduces inspection area. Water can be detected when honeycomb core is laid over, but it is best to minimize this inspection condition.

11. **Blown Core.** See figure 4. When entrapped water or other volatile in honeycomb core is heated to normal temperature, forces inside assembly created by gas pressure may be enough to locally damage or deform honeycomb core cell walls or skins of assembly. Honeycomb core expanded beyond its normal shape when compared to nearby core or core that appears severely distorted is identified as blown core. Blown core can be detected radiographically using water entrapment inspection procedures.

12. **Condensed Core.** See figure 4. Honeycomb core cell walls which deviate from expected hexagonal shape or have been partially collapsed are known as condensed core. Condensed core usually occurs in manufacturing cycle and is not considered inservice created flaw. Condensed core may be detected radiographically using water entrapment inspection procedures.

13. **Wrinkled Core.** See figure 4. Slightly buckled or corrugated honeycomb core cell walls are known as wrinkled core. Since x-rays travel in straight lines and cone of radiation contains x-rays with variations in travel path angles, uniform alternating bands of light and dark honeycomb cell wall images will be produced when some of these x-rays are coincident with portion of wrinkled core. Usually transition between light and dark wrinkled core image is not very well defined and appears slightly fuzzy. Wrinkled core is allowed condition which occurs in core or part assembly manufacturing process. It may be detected radiographically using water entrapment inspection procedures.

14. **Node Bond Failures.** See figure 4. Honeycomb core is fabricated from sheets of thin metal which are bonded together at one hexagonal cell wall. Node bond failures are defined as separation of honeycomb core node bondlines. Node bond failures will image as dark lines between junction of two honeycomb cell walls. Node bonds may also be partly separated. This honeycomb core condition can be detected radiographically with water entrapment inspection procedures. Node bond detection will be very dependent on penetrating x-ray beam alignment. If laid over node bond junction is suspected, reshoot area with x-ray beam central ray aligned with node bond junction.

15. **Foam Bonds and Foam Splices.** See figure 4. Special foaming types of adhesive are used in some areas to tie honeycomb core to closure or splice two honeycomb pieces, together. Visually and radiographically, cured foam adhesive has appearance of sponge. Porous radiographic images of this material is considered typical of structure.

a. When long faint indications are observed at foam tie bonds or at splice bonds, do additional radiographic investigations to maximize flaw detection.

b. Reshoot areas of suspected defects by correctly aligning x-ray beam central ray with defect.

c. Correct alignment with long linear faint indications may show faint indication is foam adhesive crack. If alignment appears to provide maximum contrast but flaw indication is still fuzzy, decrease unsharpness by increasing FFD or decreasing to locate film on opposite side of assembly and reshoot.

d. If x-ray technique is not given for foam bond or splice inspection and defect is suspected in foaming adhesive, begin investigation using x-ray water entrapment procedure. Add 20 percent of kV given in water entrapment procedure and use same exposure time and filament current. Increase exposure time and filament current until area of interest has a 1.5 to 2.5 H and D film density. If exposure time exceeds 3 minutes at maximum MA, increase kV until area of interest has 1.5 to 2.5 H and D film density.

16. **Fatigued Core.** See figure 4. Fatigued core is cell wall separation or tear which is result of cyclic loading. Fatigue cracks in cell walls are most reliably detected when cell walls are projected onto film as being slightly laid over. Radiographically these flaws appear as joggled alternating light and dark lines which are imaged across cell wall. Often these lines are forked and run at random angles. It is possible to have multiple failures in one cell wall. These type failures seem to occur about half way along cell wall height in assembly. As a result make sure unsharpness at mid plane of assembly is enough for correct flaw imaging.

17. **Porosity in Solid Laminates.** During fabrication of laminate material, gas is occasionally trapped at various levels within bulk material and creates flaws as planar voids or linear porosity. Certain amounts of these flaws are not considered harmful to structural integrity of part. As result planar voids or linear porosity may be images during radiographic inspection of solid laminate. Radiographically these voids appear as dark line irregular small images. Void indications are usually related with other crossing dark line indications.

18. **Crushed Core.** See figure 4. Cell wall buckling is defined as crushed core. Thin foil of cell wall has been deformed beyond elastic limit and has taken permanent set. Usually all six sides of multiple cells will be deformed when area above has been locally indented. Radiographic appearance of crushed core will depend on severity of deformation. It is possible to have only one line of plastic deformation in a cell. Severe crushing will have multiple lines of plastic deformation.

a. When crushed core is imaged from direction parallel to cell wall, central ray parallel to cell wall, deformed areas will appear as light and dark areas protruding into open cell wall areas. Make sure film density next to cell wall is low enough to image crushed areas.

b. When light crushing is imaged at slight angle, central ray not parallel to cell wall, deformed area will appear as light and dark line running across cell wall at angle perpendicular to cell wall direction. Transition between light and dark image is very sharp. Severe crushing will show many light and dark lines and localized areas which have effect of cell wall misalignment.

c. When light crushing is suspected and cannot be imaged with exposure, where central ray is parallel to cell walls, move central ray off x-ray beam center line and reshoot so area of interest is slightly laid over.

Support Equipment Required

None

Materials Required

Specification or Part Number	Nomenclature
Type 52	Black and White Polaroid Film, 4 X 5 Inch
Model 545	Polaroid Film Holder, 4 × 5 Inch

19. **DAMAGE EVALUATION OF HONEYCOMB CORE ASSEMBLIES.** Usually honeycomb core assembly is radiographed when some form of external visual damage requires inspection. Indentations, punctures, and cracks in skin are usually radiographed to provide accurate and additional damage evaluation data.

a. When surface defect triggers radiographic inspection, use specific procedure work package for water entrapment. Make sure visual damage is located next to film. Visual damage is located next to film to minimize unsharpness parameter at sub-surface damage.

NOTE

Image on this film will be radiographic positive, example; dark and light images will be reversed relative to normal x-ray film.

b. Before exposing x-ray film, expose Polarized Type 52 4 X 5 Black and White test shot to make sure of correct alignment.

(1) Locate type 52, 4 X 5, black and white film on part next to visual damage.

(2) Expose film for usable density.

(3) Insert film into Model 545, Polaroid, 4 X 5 Land film holder.

(4) Develop as instructed per film holder and film container.

(5) Evaluate for correct alignment.

(6) Repeat above steps if required.

c. After correct alignment has been completed, expose and develop x-ray film. A 1.5 to 2.5 H and D

film density in area of interest is recommended. Evaluate film for all previously identified defects. Locate all extra adhesive, foam splices, foam filled previous repair, and potted area that may influence ultrasonic inspection.

20. **REPAIR EVALUATION OF HONEYCOMB CORE ASSEMBLIES.**

a. Post repair radiography is done for reasons listed below:

(1) Check integrity of repair. Make sure repair has been tied into existing structure. Look for core adhesive separation and filler cracks.

(2) Make sure damage was not done to nearby structure during repair.

(3) Check for repair tool foreign objects which may be harmful to part.

b. For honeycomb core assemblies with core replacement and composite patch, add 20 percent to kV used during damage evaluation, and adjust exposure time and filament current to image repair areas at 1.5 to 2.5 H and D film density. Fewer shots may be required if double loaded different speed films are used during exposure.

c. For honeycomb core assemblies with core replacement and metal patch, add 20 to 40 percent to kV used during damage evaluation, and adjust exposure time and filament current to image repair areas at 1.5 to 2.5 H and D film density. Fewer shots may be required if double loaded different speed films are used during exposure.

d. For solid filled areas under composite patches, add 25 to 50 percent to kV used during damage evaluation and adjust exposure time and filament current to image repair areas at 1.5 to 2.5 H and D film density. Double loaded different film exposures are recommended.

e. For solid filled areas under metal patches add 30 to 60 percent to kV used during damage evaluation and adjust exposure time and filament current to image repair areas at a 1.5 to 2.5 H and D film density. Double loaded different film exposures are recommended.

f. Develop repair film and review. Make sure adhesive has not shrunk back from honeycomb core. Adhesive to honeycomb shrink is indicated by dark line immediately next to cell walls. Correct central ray alignment will be required to image this defect type.

g. Look for dark lines which run through solid filled areas. Shrink during cure will produce shrinkage cracks at random orientations. Alignment will be critical for correct imaging. If faint linear indication is observed in these areas re-radiograph at other angles to make most effective flaw detection.

Figure 1. Interpreting Radiographs for Water Trapped in Honeycomb

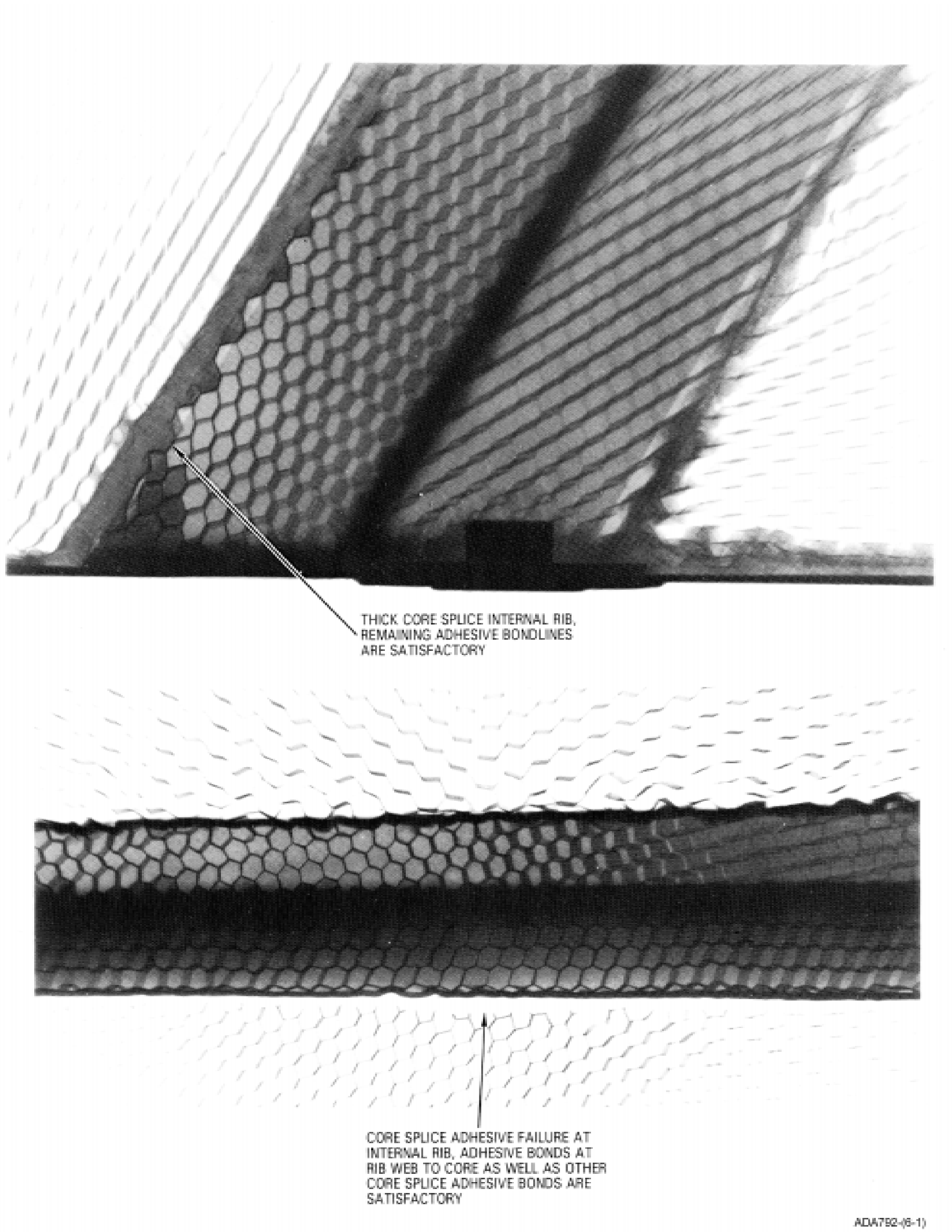


Figure 2. Interpreting Radiographs for Adhesive Separation (Sheet 1)

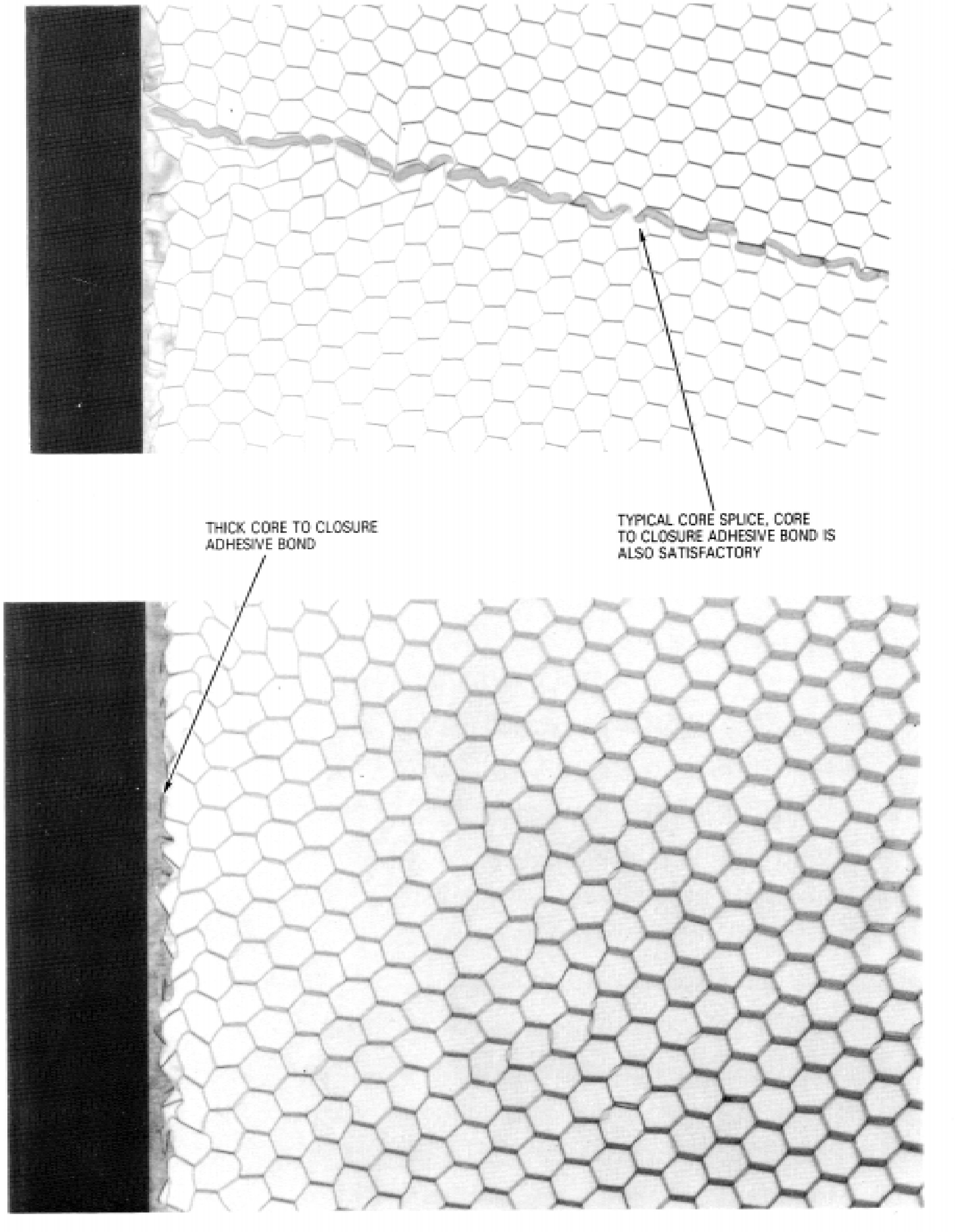
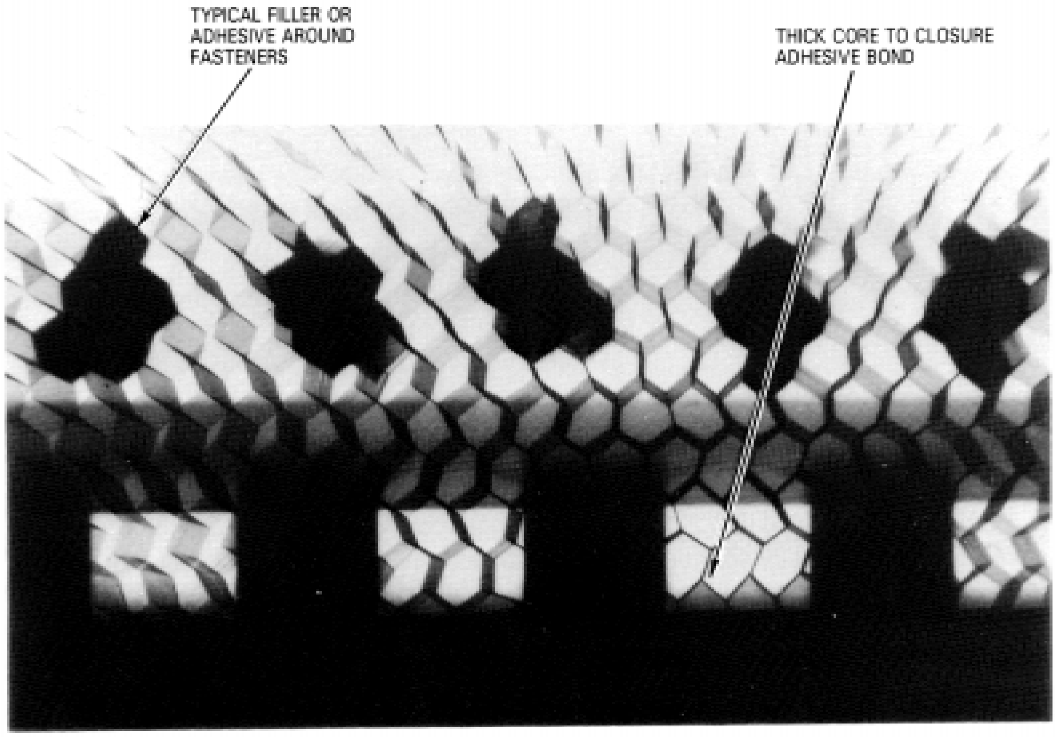


Figure 2. Interpreting Radiographs for Adhesive Separation (Sheet 2)



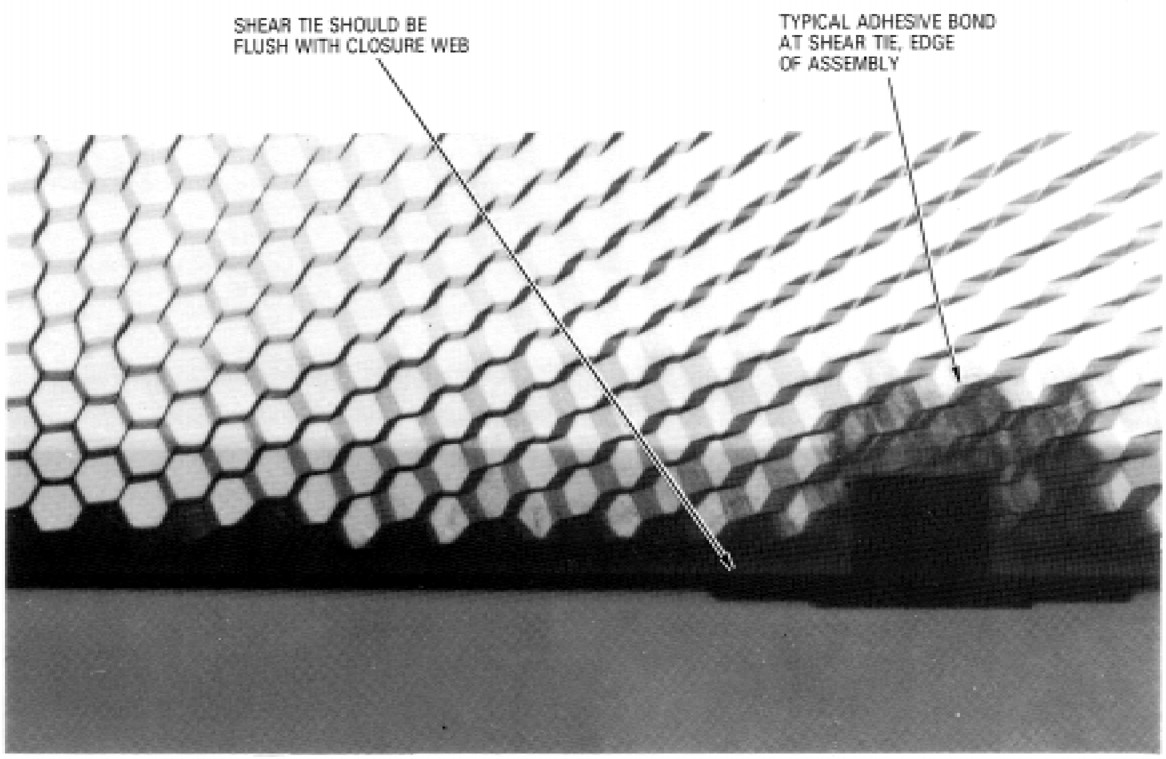


Figure 2. Interpreting Radiographs for Adhesive Separation (Sheet 3)

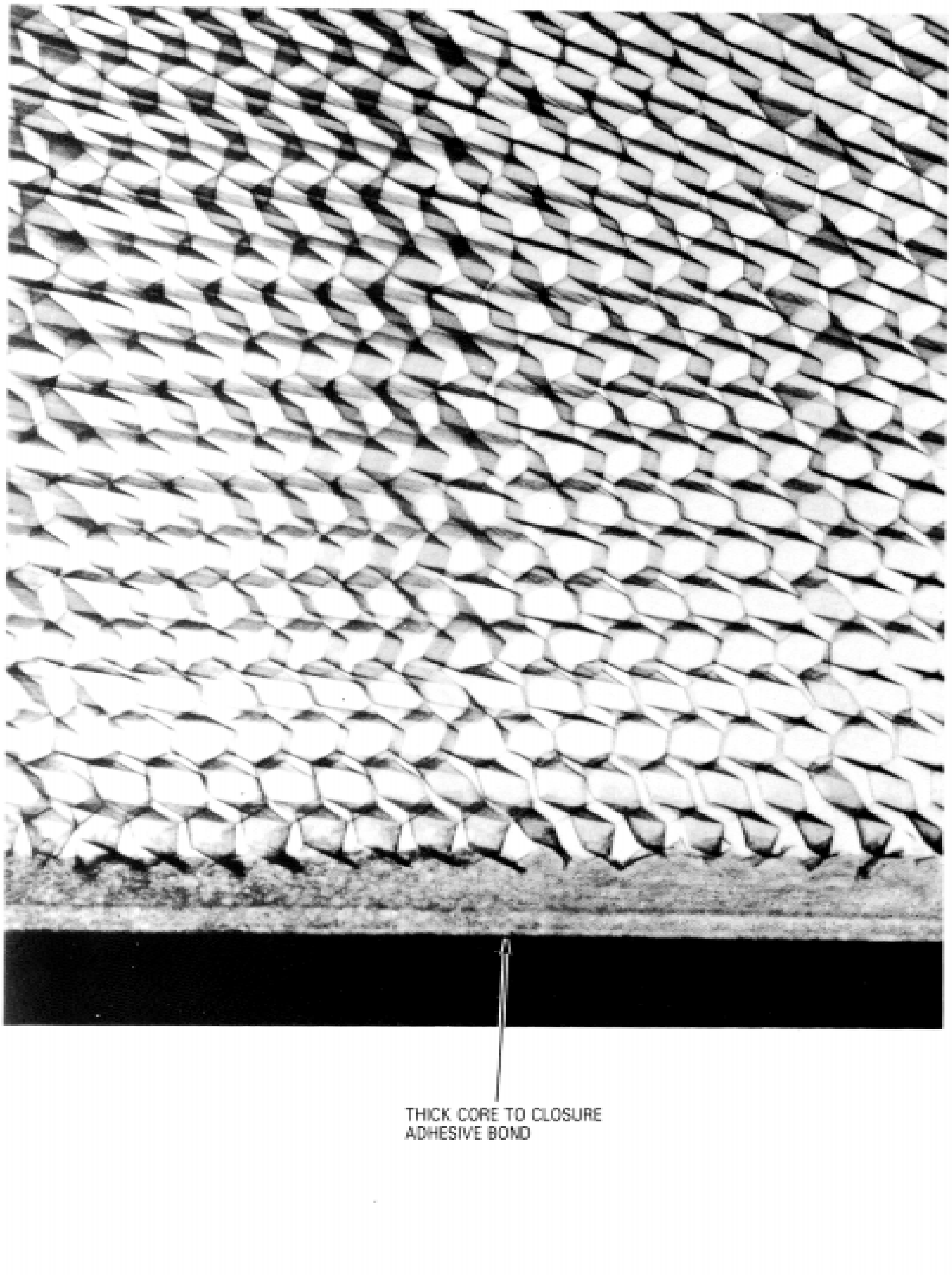


Figure 2. Interpreting Radiographs for Adhesive Separation (Sheet 4)

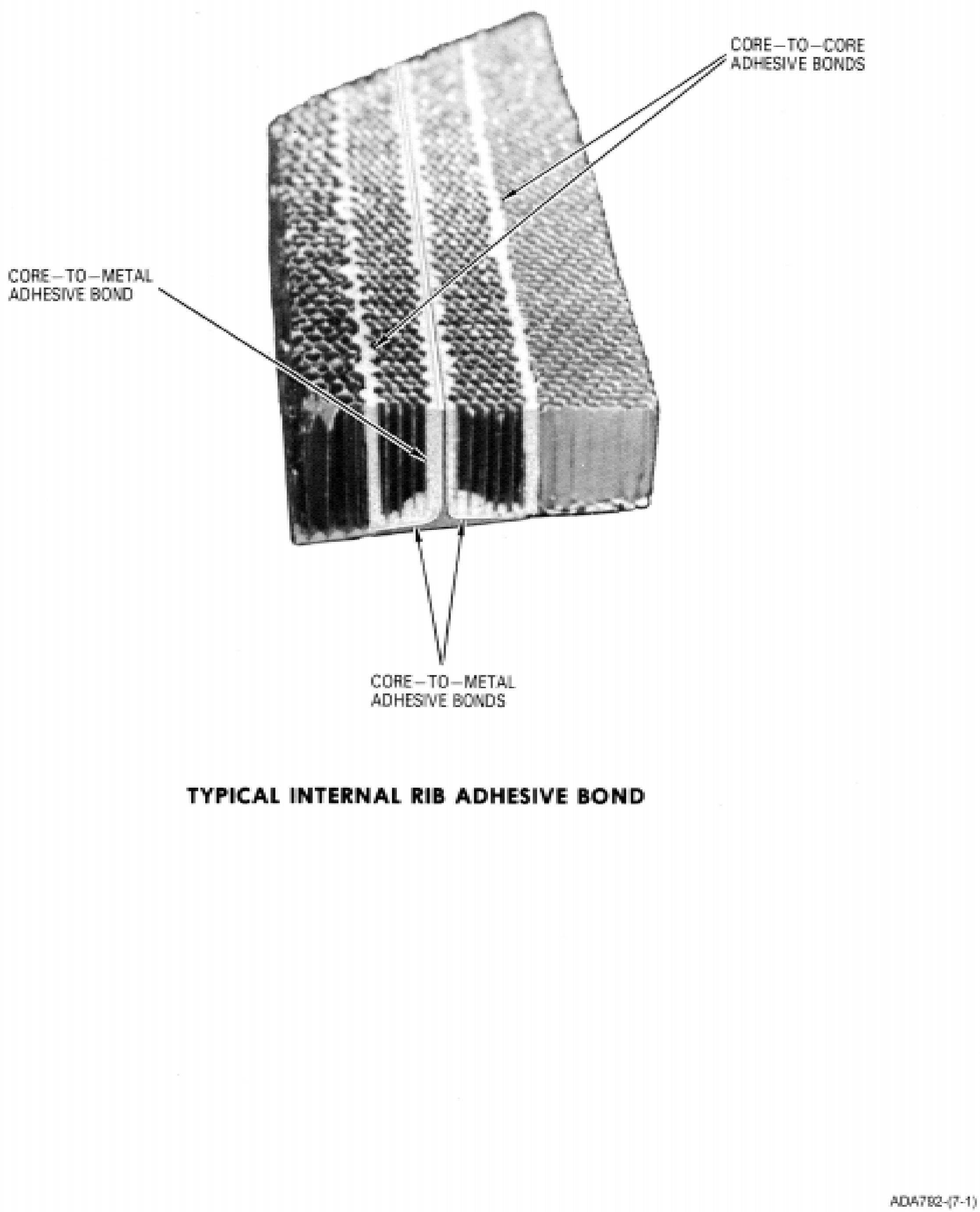
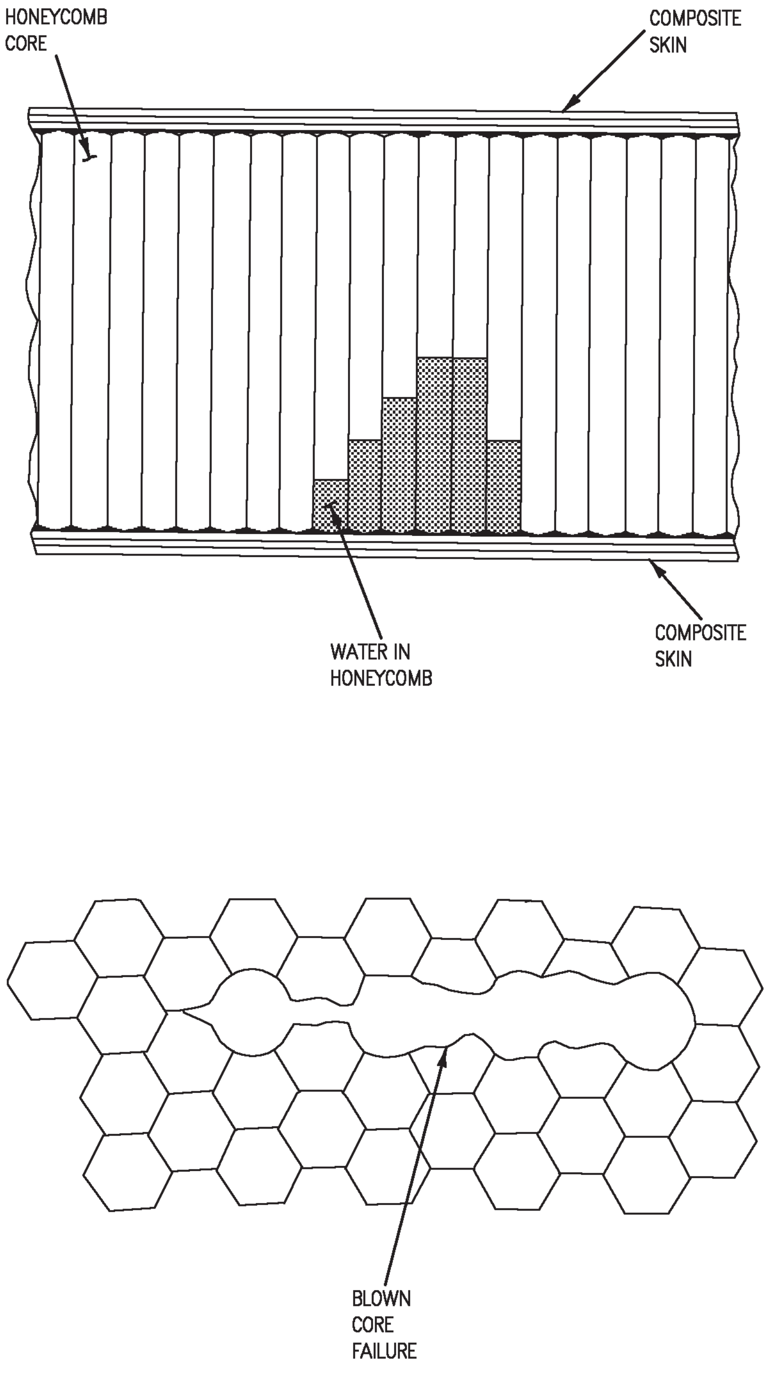
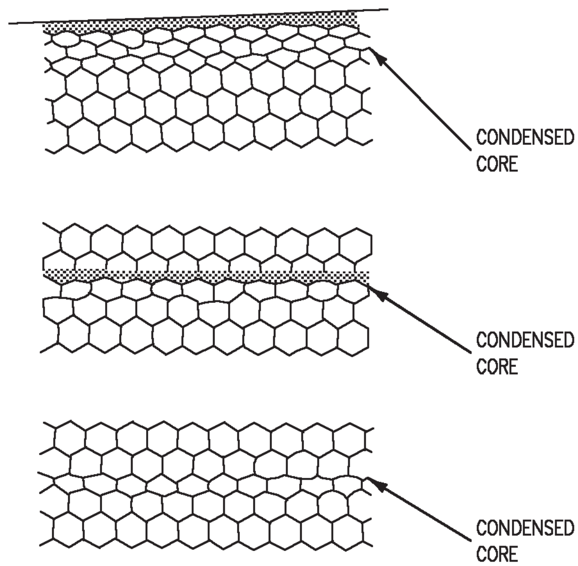


Figure 3. Interpreting Radiographs for Internal Rib Adhesive Bond

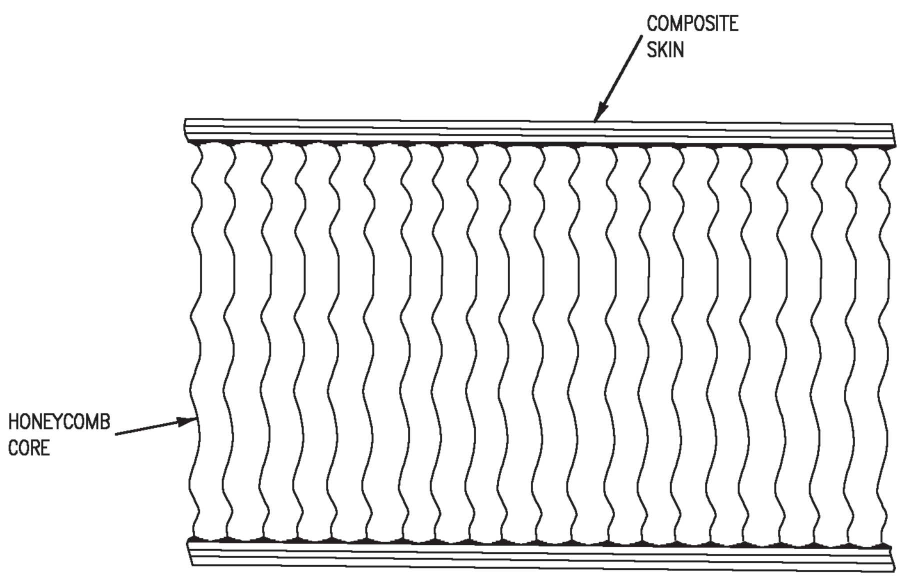


18AC-SRM-30-(8-1)21-SCAN

Figure 4. Types of Honeycomb Core Damage (Sheet 1)



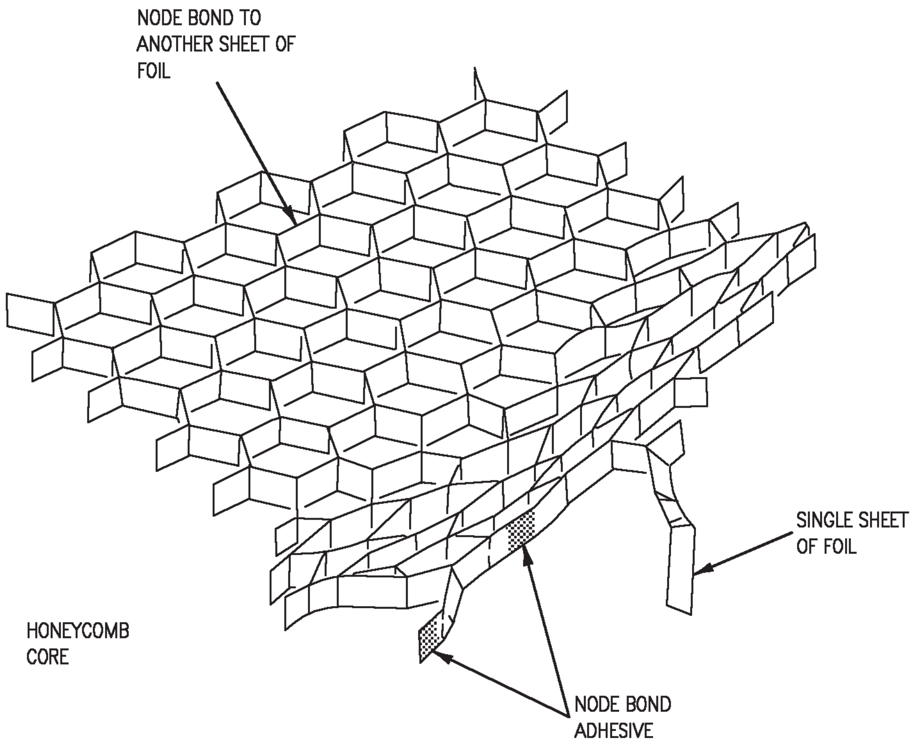
CONDENSED CORE

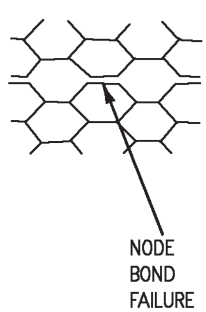


WRINKLED CORE

18AC-SRM-30-(8-2)21-SCAN

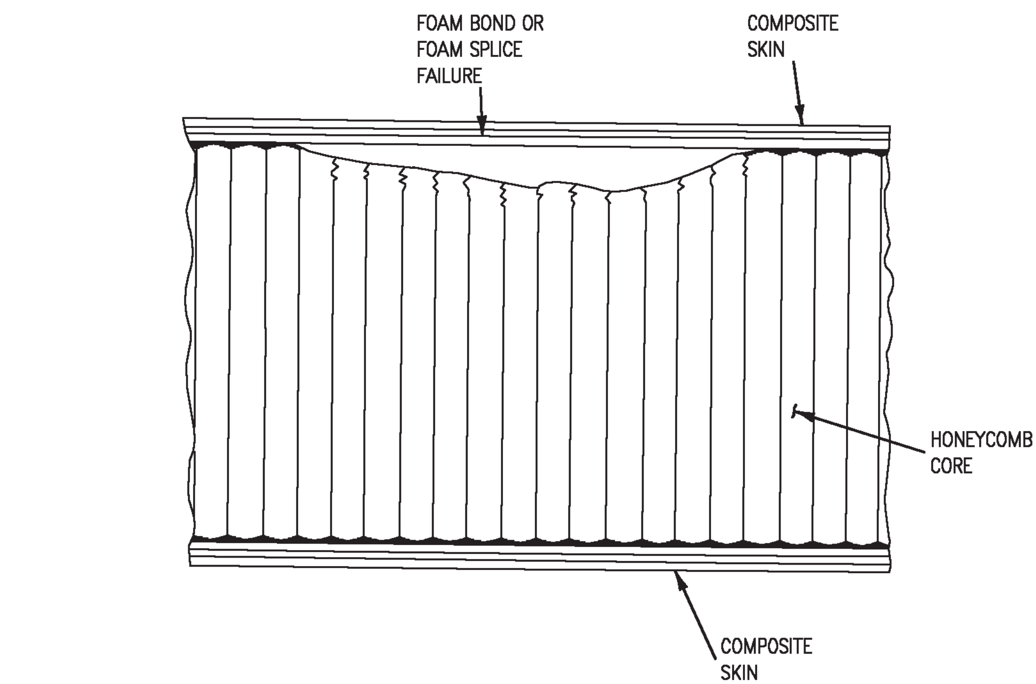
Figure 4. Types of Honeycomb Core Damage (Sheet 2)

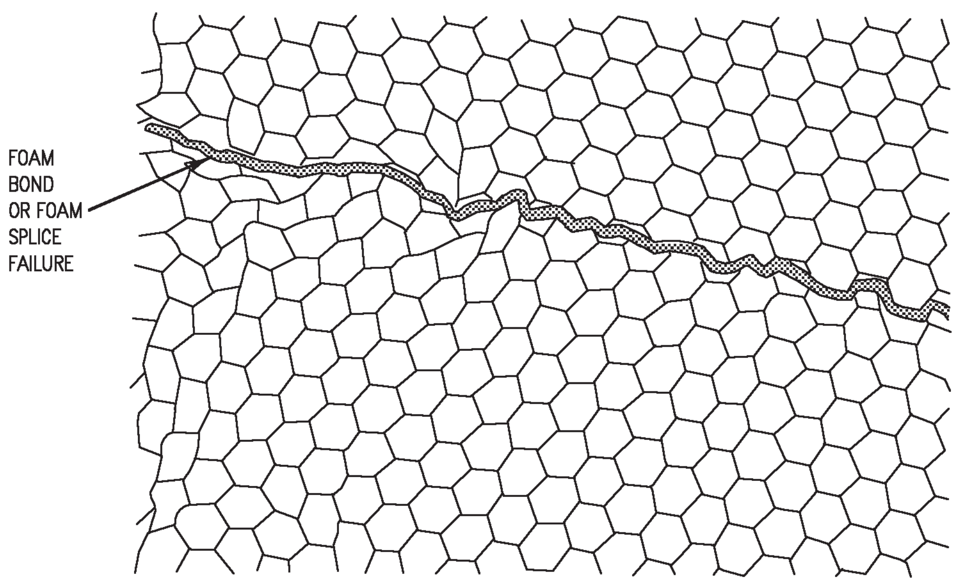




18AC-SRM-30-(8-3)21-SCAN

Figure 4. Types of Honeycomb Core Damage (Sheet 3)

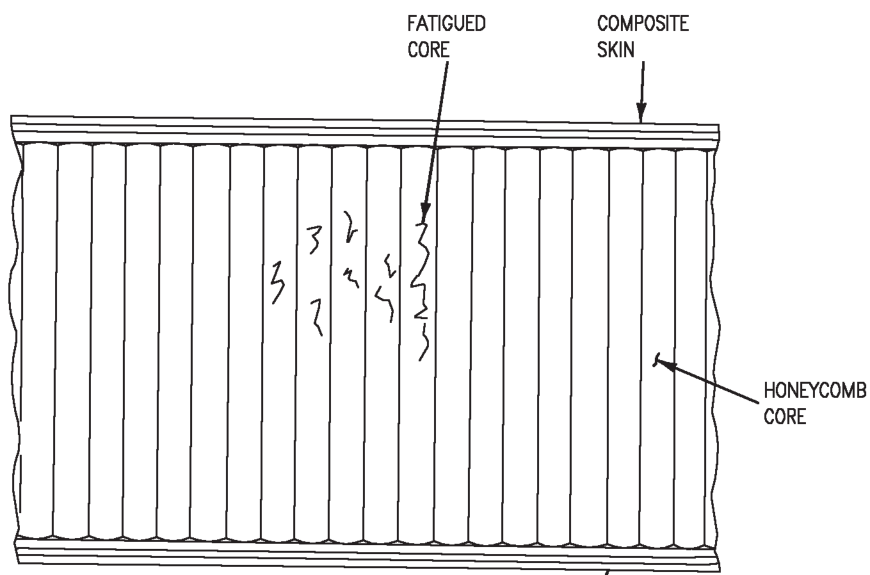




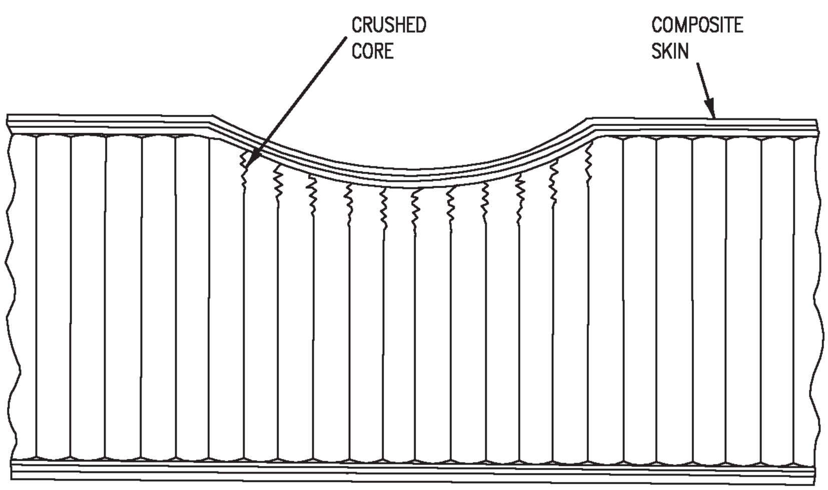
FOAM SPLICE OR
TIE IN FAILURE

18AC-SRM-30-(8-4)21-SCAN

Figure 4. Types of Honeycomb Core Damage (Sheet 4)



FATIGUED
CORE



CRUSHED
CORE

18AC-SRM-30-(8-5)21-SCAN

Figure 4. Types of Honeycomb Core Damage (Sheet 5)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

MAGNETIC PARTICLE METHOD

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection Methods	NAVAIR 01-1A-16

Alphabetical Index

Record of Applicable Technical Directives

None

1. MAGNETIC PARTICLE METHOD.

2. Magnetic particle inspection is effective in detecting surface and near surface discontinuities in ferromagnetic parts. Inspection is done by inducing magnetic field into part and applying magnetic particles, in liquid suspension or dry powder, to surface to be inspected. Local magnetic fields, formed by discontinuity in part, attract magnetic particles, producing visible indications by color contrast or by fluorescence under black light. Types of defects detected are cracks, seams, laps, folds,

and nonmetallic inclusions that are either surface or slightly subsurface.

3. **SAFETY PRECAUTIONS.**

a. Make sure safety precautions have been met for electrical, static, grounding when using electrical equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

b. Use rubber gloves to avoid skin contact with magnetic partical materials.

c. When using magnetic inspection probe (probe), such as DA200, do not exceed duty cycle. Duty cycle is 2 minutes on, 2 minutes off. Coil cover heating is indication of excessive on time.

d. For more safety precautions for specific method/application refer to procedures contained in specific procedure work packages and (NAVAIR 01-1A-16).

4. **LIGHTING REQUIREMENTS.**

NOTE

When observing background white light intensity, illuminance, black light must be turned off or removed from inspection area.

a. When using fluorescent inspection material, darkened booth or area is required where background white light intensity does not exceed 2 foot candles.

b. When using nonfluorescent inspection material, white light intensity at the surface of the part to be inspected shall be 100 foot candles or larger.

c. Measure background or inspection white light using 615-0275155 photo electric foot-candle meter or equivalent.

d. When used, ultraviolet lighting source is required that will produce at least 1,000 microwatts per square centimeter at inspection surface.

e. Measure ultraviolet light intensity using J-221, ultraviolet meter or equivalent.

5. **INSPECTION MATERIAL REQUIREMENTS.**

CAUTION

Use of dry powder inspection material is restricted to use on parts off aircraft. Use of dry magnetic powder may contaminate aircraft systems.

a. Wet inspection material is recommended for detecting surface and slightly subsurface defects and should be used unless specified in specific procedures work package.

b. Fluorescent or nonfluorescent inspection material may be used unless specified in specific procedures work package.

c. For inspection of chrome plated parts, nonfluorescent black inspection material with 2.0—2.4 milliliters (ml) of sedimentation in 100 ml of suspension is recommended.

6. PORTABLE EQUIPMENT PROCEDURES.

7. The portable probe is used for inspecting welds, small castings, and machined parts. Portable equipment is generally operated using true continuous method of inspection.

Support Equipment Required

Part Number or Type Designation	Nomenclature
DA200	Magnetic Inspection Probe
FS-3	Pie Gage, Magnetic Field Sensitivity Indicator
2480	Magnetic Particle Field Indicator
M-16 (ZB-26)	Black Light, Portable Magnetic Particle
J-221	Ultraviolet Meter
615-0275155	Photo electric foot-candle Meter, Weston Instruments Inc.

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
14AM	Fluorescent Magnetic Inspection Compound, Prepared Bath, Spray Can
10A or AMS3044	Fluorescent Magnetic Inspection Powder
9C or AMS3042	Magnetic Inspection Powder
ISOPAR M	Cutting Fluid, Used For Magnetic Particle Bath
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
M83953-1 or -2	Pencil, Aircraft Marking
MIL-C-87962, TYPE 1	Cleaning Cloth

8. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP FOR LONGITUDINAL MAGNETIZATION USING ELECTROMAGNETIC PROBE.**

NOTE

Direct current (DC) is recommended for all magnetic particle inspections especially when detection of flaws not open to surface is required.

a. Set AC/DC switch to DC or as specified in specific procedures work package.

b. Adjust magnetization intensity control to maximum.

c. Test for correct probe operation as below:

(1) With AC/DC switch set at DC and legs spaced 3 to 6 inches apart, probe should lift 30 pounds of ferromagnetic material.

(2) With AC/DC switch set to AC and legs spaced 4 to 6 inches apart, probe should lift 10 pounds of ferromagnetic material.

d. Test for enough inspection sensitivity per substeps below:

(1) Clean inspection area (NAVAIR 01-1A-16).

NOTE

False indications may occur if probe legs are positioned within 2-1/2 inches of each other.

(2) Position probe legs on part with suspected defects oriented as shown in figure 1 or as specified in specific procedures work package.

(3) Position base of pie gage against inspection surface as shown in figure 2.

WARNING

Inspection compound and powder may cause eye and skin irritation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Cutting fluid is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

CAUTION

Duty cycle for probe is 2 minutes on, 2 minutes off. Coil cover heating is indication of excessive on time.

(4) Apply inspection material to face of pie gage and immediately press ON to magnetize part. Linear indications should form in direction of suspected flaw on face of pie gage. Failure of indication to form on face of pie gage could be result of equipment malfunction, ineffective inspection material, or incorrect technique.

9. **INSPECTION PROCEDURE FOR TRUE CONTINUOUS LONGITUDINAL MAGNETIZATION USING ELECTROMAGNETIC PROBE.**

a. Clean part to be inspected (NAVAIR 01-1A-16).

b. Position probe legs on part per specific procedures work package or (NAVAIR 01-1A-16).

CAUTION

Duty cycle for probe is 2 minutes on, 2 minutes off. Coil cover heating is indication of excessive on time.

c. Apply inspection material to inspection surface and immediately press ON to magnetize part.

d. Mark all indications with aircraft marking pencil.

e. Reposition probe legs 90 degrees from original position or as specified in specific procedures work package or (NAVAIR 01-1A-16) and repeat steps b through d.

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

f. Clean inspection material from part with solvent moistened cloth.

10. **EVALUATIONS AND DISPOSITIONS.**

a. Polar effects as result of design factors, for example; keyways, drilled holes and abrupt changes in section, may cause indications which are nonrelevant. Current intensities should be adjusted to minimize these effects, primarily during longitudinal magnetization.

b. Some metallurgical discontinuities and magnetic permeability variations may also cause indications which are nonrelevant.

c. When indication is not believed to be relevant it should be evaluated as not satisfactory until indication is either removed by surface conditioning or reinspected by same or other nondestructive inspection method and shown to be nonrelevant.

NOTE

Grind burn indications are sometimes slow in appearing with longitudinal method.

d. Chromium plated parts, that have been ground, should also be inspected for grinding burns under the chromium. Grinding burns appear as annular magnetic rings and may not be related to grinding cracks.

11. **DEMAGNETIZATION.**

a. Set AC/DC switch to AC.

b. For small parts, turn probe control to MAXIMUM and apply AC magnetization. Pass parts through area between poles of probe and withdraw parts to minimum distance of 3 feet from probe before turning probe OFF.

c. For large parts, demagnetize parts in same position as they were magnetized. Turn probe control to MAXIMUM and apply AC magnetization. Keep magnetization switch on and slowly move probe away minimum of 3 feet, turn probe OFF.

d. Use 2480 field indicator to determine amount of demagnetization. If indicator moves over two graduations on either side of scale, repeat steps a through c.

12. STATIONARY EQUIPMENT PROCEDURES.

13. Two basic methods of magnetization used with stationary equipment are circular and longitudinal.

a. Circular magnetization is applied by passing current through part or central conductor while clamped between contacts of stationary unit, see figures 3 and 4 and (NAVAIR 01-1A-16).

b. Longitudinal magnetization is applied by putting part into magnetic field generated by a coil, see figure 5 and (NAVAIR 01-1A-16).

NOTE

Circular magnetization should be done before longitudinal magnetization to allow more effective demagnetization.

Support Equipment Required

NOTE

Alternate type designations or part numbers listed in parentheses.

Part Number or Type Designation	Nomenclature
H-710G	Stationary Magnetic Particle Inspection Unit
SB2824 (SB2814)	Demagnetizer Coil
FS-3	Pie Gage, Magnetic Field Sensitivity Indicator
2480	Magnetic Particle Field Indicator, Magnaflux Corp.
M-16 (ZB-26)	Black Light, Portable Magnetic Particle
J-221	Ultraviolet Meter
615-0275155	Photoelectric Foot-candle Meter, Weston Instruments, Inc.

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
10A or AMS3044	Fluorescent Magnetic Inspection Powder, Red
9C or AMS3042	Magnetic Inspection Powder, Black

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
14AM	Fluorescent Magnetic Inspection Compound, Prepared Bath, Spray Can
ISOPAR M	Cutting Fluid, Used For Magnetic Particle Bath
M83953-1 or -2	Pencil, Aircraft Marking
MIL-C-87962, TYPE I	Cleaning Cloth

14. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP FOR CIRCULAR MAGNETIZATION USING STATIONARY EQUIPMENT.**

a. Set CONTACT/COIL switch at CONTACT.

b. Set AC/DC switch at DC.

c. Adjust PULSE LENGTH setting to 1/2-second.

d. Test for correct equipment operation (NAVAIR 01-1A-16).

e. Test for enough inspection sensitivity and correct field direction per substeps below:

(1) Clean inspection area(s) (NAVAIR 01-1A-16).

(2) Decrease CURRENT to minimum.

CAUTION

Make sure current pushbar is not depressed while positioning part to avoid damaging part by arcing. When part is positioned for magnetization, make sure part is not in contact with any grounded component to avoid damaging part by arcing.

(3) Position part between tailstock and headstock or on central conductor as described in specific procedures work package or (NAVAIR 01-1A-16).

(4) Position base of pie gage against surface of inspection area.

WARNING

Inspection compound and powder may cause eye and skin irritation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Cutting fluid is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

Make sure wet inspection material, when applied by hosing, is not flowing on pie gage during magnetization, but is diverted or shut off before application of current.

(5) Apply inspection material to face of pie gage, divert or shutoff inspection material flow, and immediately press pushbar to magnetize part with 1/2-second pulse (shot) of current while monitoring ammeter.

(6) Adjust amperage setting, as required, and remagnetize part with 1/2-second shot of current. Repeat amperage adjustments on magnetization pulses until correct amperage is indicated on ammeter. Refer to specific procedures work package or (NAVAIR 01-1A-16) for correct amperage level.

(7) Linear indications should form in direction of suspected flaw on face of pie gage. Failure of indication to form on face of pie gage could be result of equipment malfunction, ineffective inspection material, or incorrect technique.

15. **INSPECTION PROCEDURE FOR CONTINUOUS CIRCULAR MAGNETIZATION USING STATIONARY EQUIPMENT.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean part to be inspected with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Before doing inspection, refer to specific procedures work package to identify inspection area(s), and location and direction of suspected defect(s).

c. Position part between headstock and tailstock as shown in specific procedures work package or (NAVAIR 01-1A-16). When inspecting hollow parts with central conductor, position one side of part against central conductor and inspect only effective area of magnetization, see figure 4.

NOTE

Make sure wet inspection material, when applied by hosing, is not flowing on part during magnetization, but is diverted or shut off before application of current.

d. Apply inspection material to surface of inspection area(s), divert or shut off inspection material flow, and immediately press pushbar to magnetize part with 1/2-second shot of current. While viewing inspection area(s) magnetize part with two more current shots.

e. Mark all areas with aircraft marking pencil where accumulation of magnetic particles indicate defect.

NOTE

When more than one circular magnetization operation is required, begin with lowest current level operation and continue with next higher current level operation.

f. Reposition part and repeat magnetization operation to inspect all inspection area(s) of part, refer to specific procedures work package or (NAVAIR 01-1A-16).

g. Clean inspection material from inspection area(s).

h. Demagnetize part per paragraph 19 and (NAVAIR 01-1A-16).

16. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP FOR LONGITUDINAL MAGNETIZATION USING STATIONARY EQUIPMENT.**

a. Set CONTACT/COIL switch to COIL.

b. Set AC/DC switch to DC.

c. Adjust PULSE LENGTH setting at 1/2-second.

d. Test for correct equipment operation (NAVAIR 01-1A-16).

e. Test for enough inspection sensitivity and field direction per substeps below:

(1) Clean inspection area(s) (NAVAIR 01-1A-16).

(2) Decrease CURRENT to minimum.

CAUTION

Make sure current pushbar is not depressed while positioning part to avoid damaging part by arcing. Make sure part is not in contact with any grounded component to avoid damaging part by arcing.

(3) Position part in coil as shown in specific procedure work package or (NAVAIR 01-1A-16).

(4) Position base of pie gage against surface of inspection area(s).

NOTE

Make sure wet inspection material, when applied by hosing, is not flowing on pie gage during magnetization, but is diverted or shut off before application of current.

(5) Apply inspection material to face of pie gage, divert or shut off inspection material flow, and immediately press pushbar to magnetize part with 1/2-second shot of current while monitoring ammeter.

(6) Adjust amperage setting, as required, and remagnetize part with 1/2-second pulse of current. Repeat amperage adjustments on magnetization pulses until correct amperage is indicated on ammeter. See specific procedures work package or (NAVAIR 01-1A-16) for correct amperage level.

(7) Linear indications should form in direction of suspected flaw on face of pie gage. Failure of indication to form on face of pie gage could be result of equipment malfunction, ineffective inspection material, or incorrect technique.

17. **INSPECTION PROCEDURE FOR CONTINUOUS LONGITUDINAL MAGNETIZATION USING STATIONARY EQUIPMENT.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean part to be inspected with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Before doing inspection, refer to specific procedures work package to identify inspection area(s), and location and direction of suspected defect(s).

c. Position part in coil as shown in specific procedures work package or in (NAVAIR 01-1A-16), see figure 5.

NOTE

Make sure wet inspection material, when applied by hosing, is not flowing on part during magnetization, but is diverted or shut off before application of current.

d. Apply inspection material to surface of inspection area(s), divert or shut off inspection material flow, and immediately press pushbar to magnetize part with 1/2-second shot of current. While viewing inspection area(s) magnetize part with two more current shots.

e. Mark all areas, with aircraft marking pencil where accumulation of magnetic particles indicate defect.

NOTE

When more than one longitudinal magnetization operation is required, begin with lowest current level operation and continue with next higher current level operation.

f. Reposition part and repeat magnetization operation to inspect all inspection area(s) of part, refer to specific procedures work package or (NAVAIR 01-1A-16).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

g. Clean inspection material from inspection area(s) with solvent moistened cloth.

18. **EVALUATIONS AND DISPOSITIONS.**

a. Polar effects as result of design factors, for example; keyways, drilled holes, and abrupt changes in section, may cause indications which are nonrelevant. Current intensities should be adjusted to minimize these effects, primarily during longitudinal magnetization.

b. Some metallurgical discontinuities and magnetic permeability variations may also cause indications which are nonrelevant.

c. When indication is not believed to be relevant it should be evaluated as not satisfactory until indication is either removed by surface conditioning or reinspected by same or other nondestructive inspection method and shown to be nonrelevant.

NOTE

Grind burn indications are sometimes slow in appearing with the longitudinal method.

d. Chromium plated parts, that have been ground, should also be inspected for grinding burns under the chromium. Grinding burns appear as annular magnetic rings and may not be related to grinding cracks.

19. **DEMAGNETIZATION.**

a. When using AC demagnetizing coil, hold part about 1 foot in front of coil and then move it slowly and steadily through coil and then 1 foot beyond end of unit. Repeat this process several times if part does not readily lose its residual magnetism. Rotate and tumble parts of complex configuration while passing through field of coil.

NOTE

Reversing DC cycle should be repeated until residual field is depleted.

b. When 30 point automatic reversing DC demagnetizing unit is used, demagnetize part in same position as it was magnetized.

NOTE

Field indicators should be standardized in quantitative values of oersteds and should show maximum error of ±1.8 oersted in range from –6 to +6 oersted. Field indicators should be standardized at intervals not exceeding 6 months.

c. Use 2480 or equivalent field indicator to determine amount of demagnetization. If needle moves over two or more graduations on either side of zero, repeat steps a or b as required.

d. Clean traces of inspection material from part.

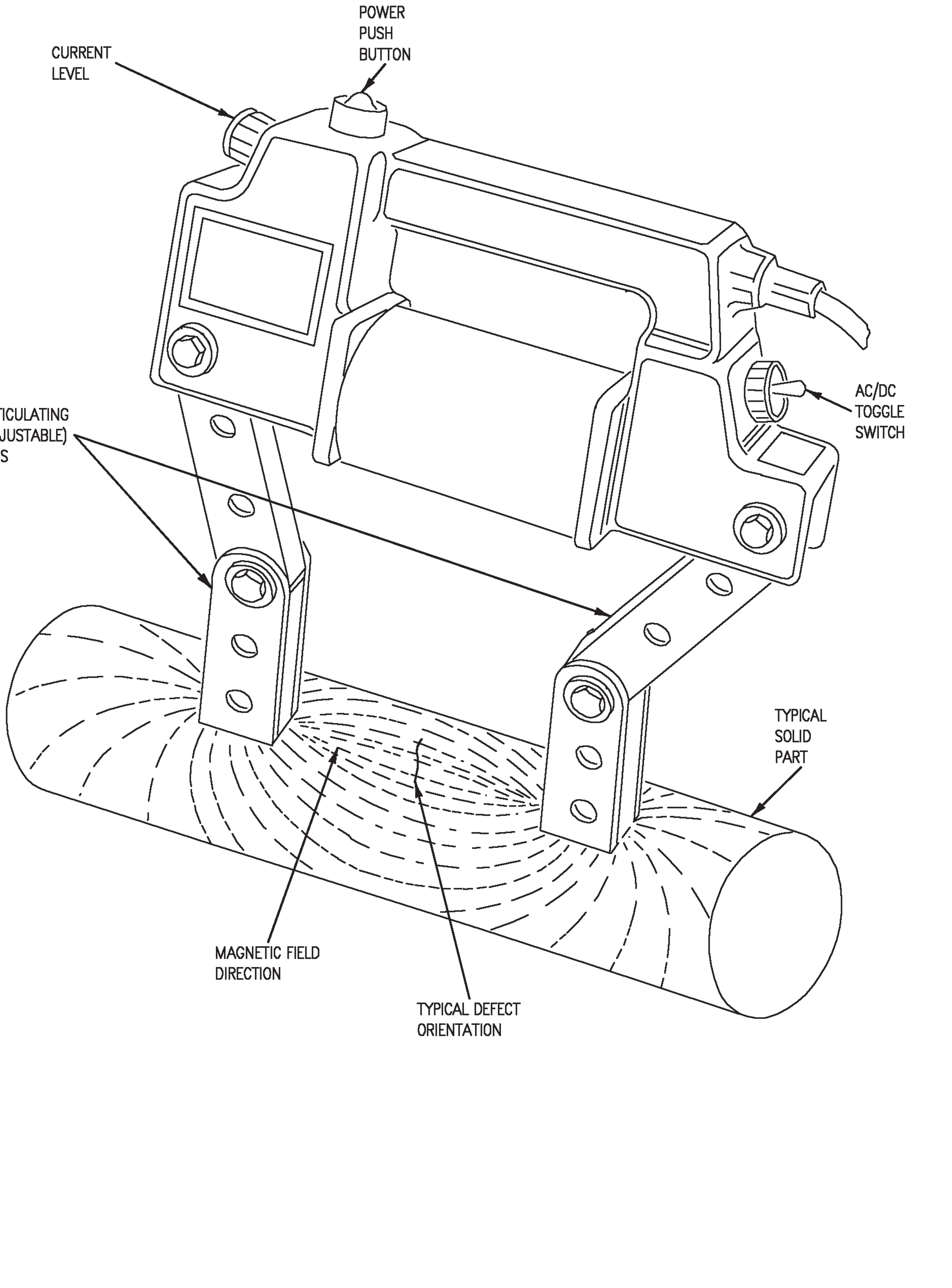


Figure 1. Probe with Articulating Legs

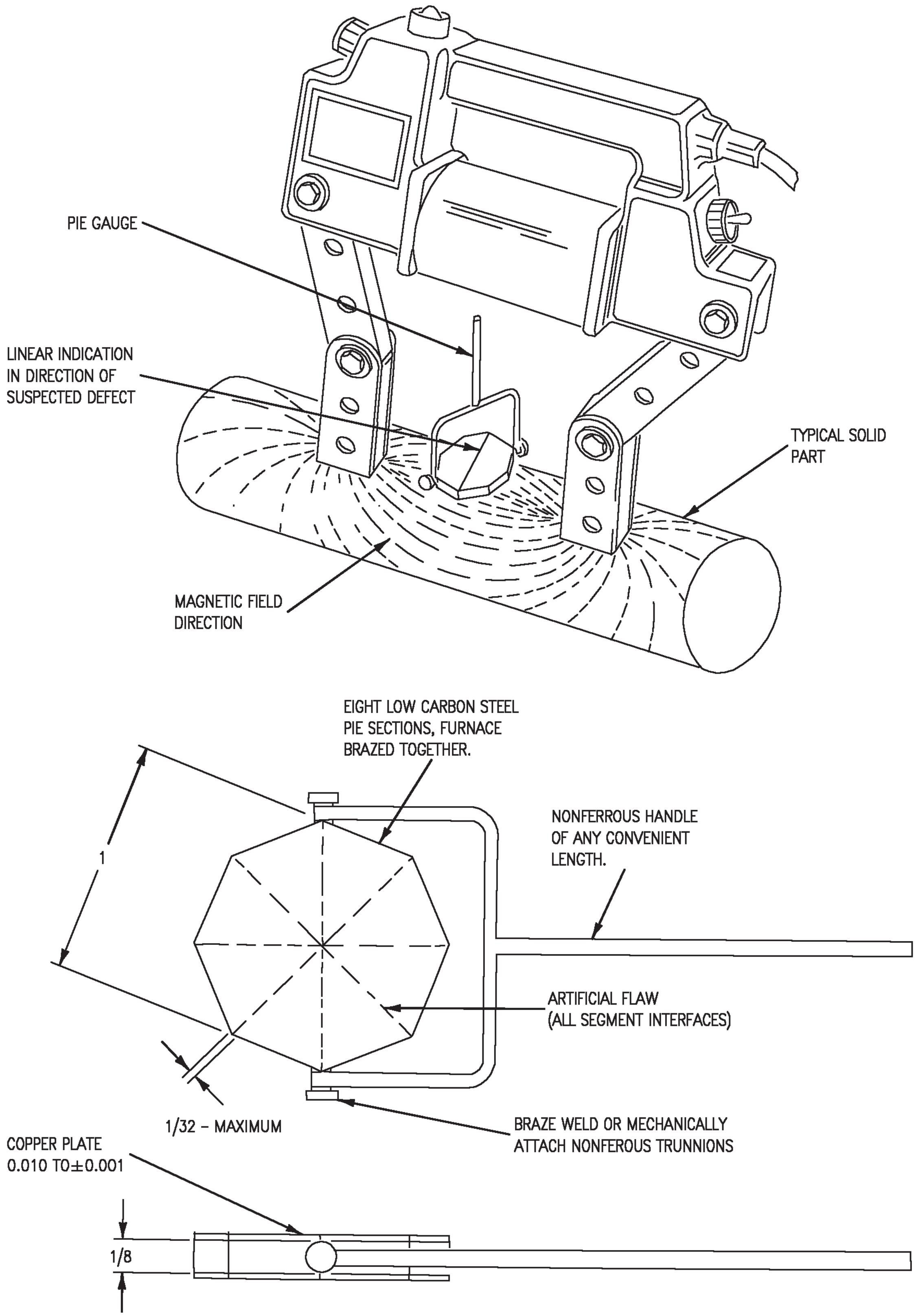


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Figure 2. Typical Field Sensitivity Indicator

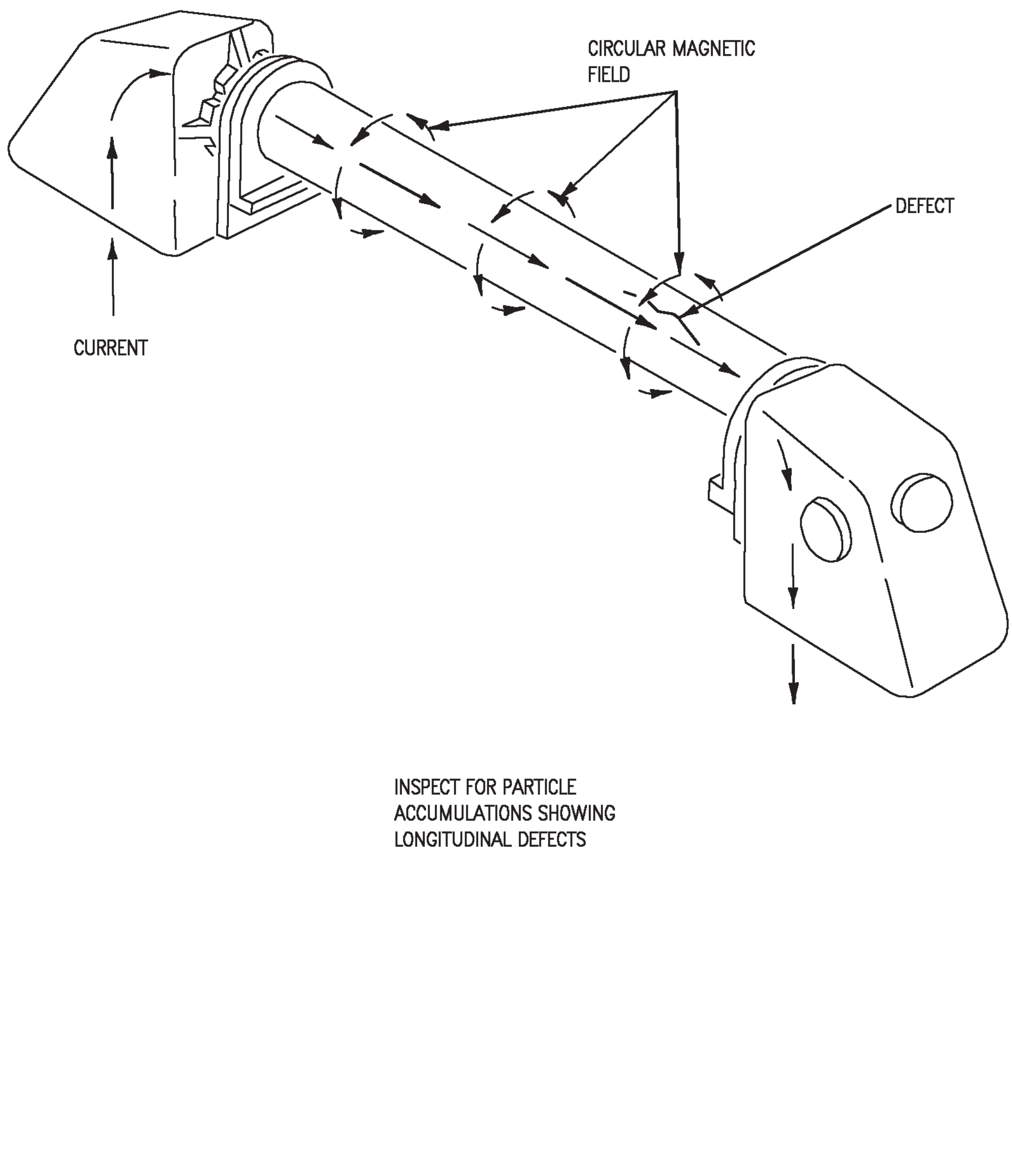


Figure 3. Typical Circular Magnetization of Solid Part Using Stationary Equipment

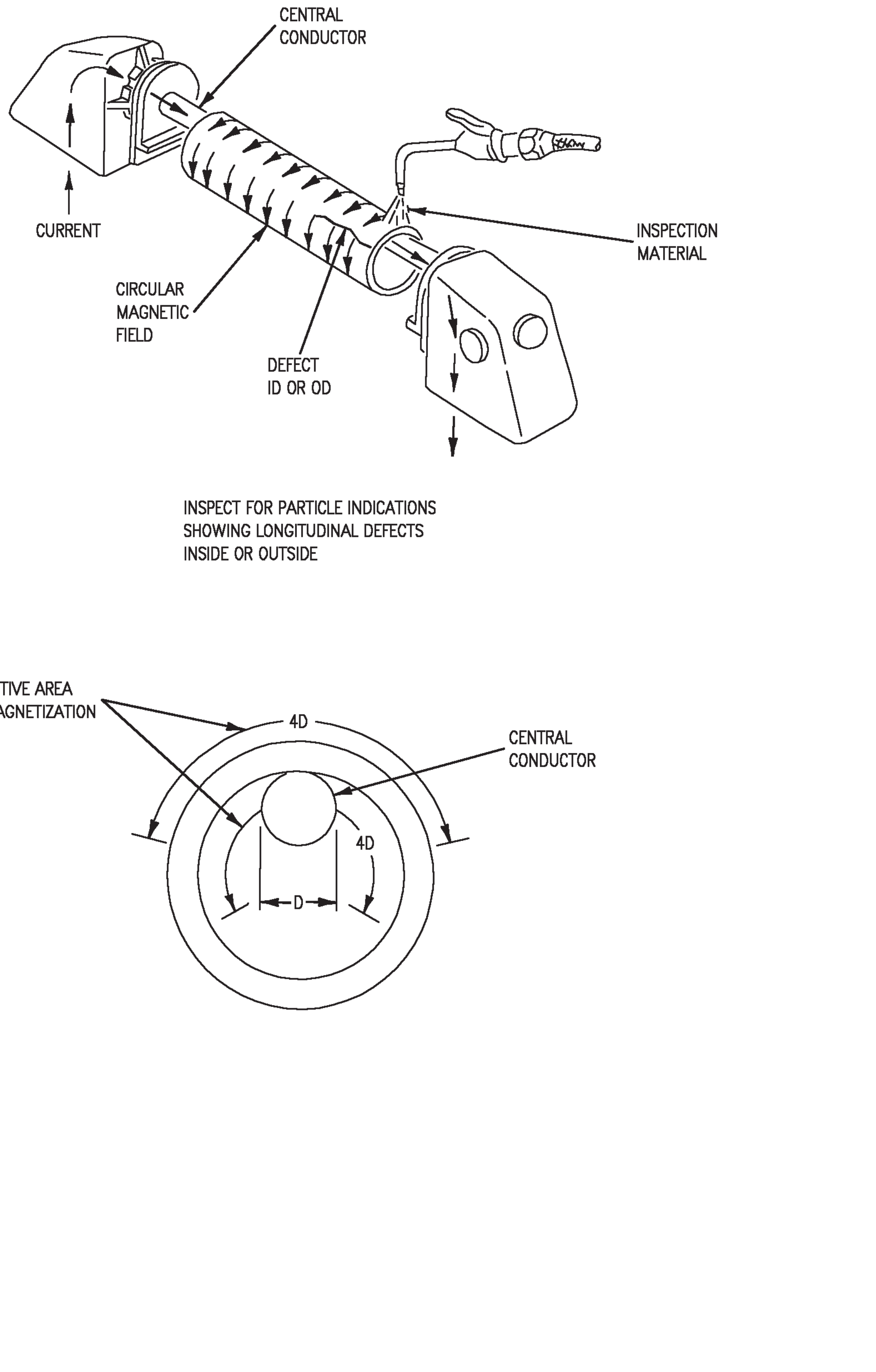


Figure 4. Typical Circular Magnetization Using Central Conductor with Stationary Equipment

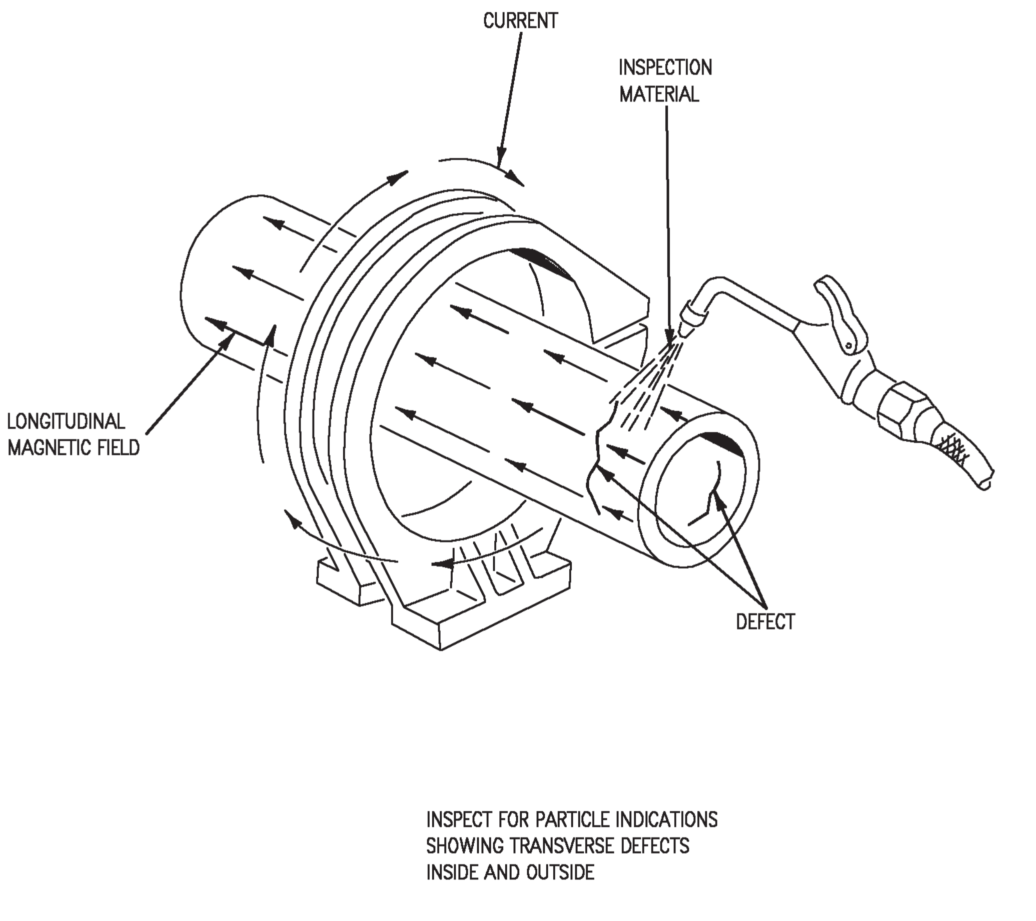


Figure 5. Typical Longitudinal Magnetization Using Stationary Equipment

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT SURFACE INSPECTION OF ALUMINUM AND ALUMINUM ALLOYS WITH METER TYPE INSTRUMENTS

Reference Material

Plane Captain Manual A1-F18AC-PCM-000
Naval Aviation Maintenance Program .... OPNAVINST 4790.2

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. This work package defines safety precautions, surface preparation, eddy current flaw detector (tester) setup, and procedure for doing surface inspections.

3. **SAFETY PRECAUTIONS.** Make sure safety precautions have been met for electrical, static, grounding when using electrical equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Reference standard is considered equivalent for surface inspection if it is made of same base material and contains 2 EDM notches between 0.005 and 0.020 inches deep, at least 0.2 inches long, and from 0.002 to 0.005 inches wide.

Part Number or Type Designation	Nomenclature
ED520 (EC 5000)	Eddy Current Flaw Detector, Magnatest or Parker Instruments
NRK-3AST or EQUIVALENT	Navy Reference Standard Kit, NDT Engineering Corp.
GPK-36/FA-18	Navy Eddy Current Probe Kit, NDI Engineering Corp.
FG1	Flaw Gate, GK Engineering
COMMERCIAL	Hole Template, Draftsman Plastic Circle Template
COMMERCIAL	Scale, Ruler

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
GENERIC	Any cleaning solvent locally approved for use and acceptable per local environmental regulations.

Materials Required (Continued)

Specification or Part Number	Nomenclature
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
673T	Tube Type Marker

5. **FLAW DETECTOR SETUP.**

a. Connect tester to power supply or use batteries. If batteries are used, test for correct charge. Needle should be above red line on meter scale and not drift down scale during 15 second test. Recharge batteries, if required.

b. Connect probe, specified in specific procedure work package or probe from probe kit, to tester, refer to table 1.

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit.

Probe P/N	Frequency	Description
MP-30	200 kHz	F.S., Straight Shaft, 1/8 Inch Dia., 3 Inches Long
MP475-50C	200 kHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip
MP9003-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.03 Inch Drop
MP902-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.2 Inch Drop

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP9003-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.3 Inch Drop
MP902-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.2 Inch Drop
MP905-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.5 Inch Drop
MP9003-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.3 Inch Drop
MP902-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.2 Inch Drop
MP905-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.5 Inch Drop
MP-60FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 3 Inches Long,
MP-100FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 10 Inches Long,

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP902-60FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 6 Inches Long, 0.2 Inch Drop
MP902-100FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 10 Inches Long, 0.2 Inch Drop
TPF-902-	200 kHz	Finger Tip Probe, F.S., 1/8 Inch Dia., 90 Degree, 0.2 Inch Drop
AR4C-F/A18	200 kHz	Array Probe, 4 Coil Absolute, 1/2 Inch Wide, Unshielded
MP-30/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., Straight, 3 Inches Long
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip
MP-9003-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.03 Inch Drop
MP902-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.02 Inch Drop

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP-905-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.05 Inch Drop
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Drop
Notes: 1. F.S. =Ferrite Shielded.		

c. Turn FUNCTION to LO.

d. Turn SENSITIVITY INC to MINIMUM, fully counterclockwise.

e. Turn LIFT-OFF/FREQ and BALANCE to ZERO, fully counterclockwise.

f. Position probe on surface of ARK-3AL reference standard, which is part of NRK-3AST Navy reference standard kit, see figure 1. Make sure probe is not over any notch, engraving, near edge, or hole.

g. Set meter needle on scale by adjusting BALANCE.

h. If BALANCE does not locate meter needle on scale, return BALANCE to ZERO and turn LIFT-OFF/FREQ clockwise 0.1 turn or 10 small divisions, repeat step g, and see figure 2.

i. If required, repeat step h to get meter needle on scale.

NOTE

Direction of needle deflection is critical for correct setup. Make sure following steps are read completely and carefully before making control adjustments.

j. Slowly turn LIFT-OFF/FREQ clockwise observing needle movement direction. Clockwise rotation of this control may cause upscale, downscale, or possibly offscale, deflection of meter needle. For initial downscale deflection of meter needle, continue slow clockwise rotation of LIFT-OFF/FREQ until upscale needle deflection is observed. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

k. Continue slow clockwise rotation of LIFT-OFF/FREQ until meter needle movement changes from upscale to downscale. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

NOTE

Correct crossover point is indicated by meter needle movement up, then down scale, while turning LIFT-OFF/FREQ clockwise, see figure 3.

l. After getting correct crossover point, decrease LIFT-OFF/FREQ 0.2 turn, 20 small divisions, counterclockwise for non-shielded probes or 0.4 turn, 40 small divisions, for ferrite shielded probes.

NOTE

Tester should be set near 0.003 inch lift-off compensation. Following setup objective is to confirm lift-off compensation by producing zero needle deflection or same meter indication with or without paper shim between probe and reference standard.

m. Put sheet of paper, 0.002 to 0.004 inch thick, measure with thickness gage, between probe and reference standard. See figure 4.

n. Using BALANCE, adjust meter needle to approximately 250 microamperes.

o. Remove paper from under probe and observe direction and amount of meter needle deflection, see figure 4.

(1) For downscale needle deflection or off scale downward deflection, when probe is on bare material, adjust LIFT-OFF/FREQ 1/2-to 10 small divisions counterclockwise.

(2) For upscale needle deflection or off scale upward deflection, when probe is on bare

material, adjust LIFT-OFF/FREQ 1/2-to 10 small divisions clockwise.

p. After any adjustments to LIFT-OFF/FREQ, position 0.002 to 0.004 inch thick paper between probe and reference standard. Use BALANCE to set meter needle at 250 microamperes.

q. Repeat steps m through p using larger or smaller amounts of LIFT-OFF/FREQ or until there is no needle deflection when probe is placed on reference standard, with or without paper.

r. Lock LIFT-OFF/FREQ. Tester is adjusted for lift-off compensation.

s. Make sensitivity adjustment for surface inspection as follows;

(1) Select FUNC mode specified in specific procedure work package to get required inspection sensitivity. If FUNC mode is not specified, set FUNC mode on HI.

(2) Position coil part of probe on surface of reference standard away from any notch, engraving, hole, or edge. See figure 1.

(3) Set meter needle on 250 microamperes by adjusting BALANCE.

(4) Pass coil part of probe over 0.020 inch notch. Needle deflection of about 150 microamperes should be observed.

(5) If deflection is not within 20 microamperes of 150 , adjust SENSITIVITY INC until deflection is in correct range. If correct range can not be reached, replace probe or tester.

WARNING

Cleaning solvent is toxic to eyes, skin, or respiratory tract. Skin/eye protection is required. Avoid repeated/prolonged contact. Use only in well ventilated areas.

6. **SURFACE PREPARATION.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

7. **INSPECTION PROCEDURE.**

a. Surface inspection considerations;

(1) Scanning around fasteners. Use nonconductive template for probe guide. See figure 5. Select template hole diameter large enough to make sure probe does not contact fastener, but at same time locates probe close as possible to fastener or fastener hole.

NOTE

Probe guide allows spacing between fastener(s) and eddy current probe. Probe guide Spacing prevents generation of crack like response from edge effects or lift-off noise. Both of these indications are related with inspecting to close to steel fasteners in nonferrous parts. Probe guides are not required when using ferrite shielded probes, but use is still recommended.

(2) Scanning around steel fasteners. After determining fasteners are steel in nonferrous part, use probe guide to scan around or between fasteners. Fit probe guide snugly around fastener. See figure 6

(3) Scanning between fasteners is identical to scanning around fasteners, except areas made inaccessible by part configuration or close fastener patterns are omitted. See figure 7.

b. Surface inspection, aluminum parts only.

(1) Position probe on part to be inspected in area known to be free of cracks.

(2) Use BALANCE to set meter needle at 250 microamperes.

(3) Scan inspection surfaces by moving probe at constant speed, no greater than speed required to get flaw response on reference standard.

NOTE

Paint thickness variations may cause meter deflections. Generally, these deflections will not be sharply defined like responses from cracks. Part thickness changes and machined subsurface edges should be marked on surface for comparison reasons; these thickness changes and edges will cause meter deflection sharply defined as cracks. Sharp movements down scale are characteristic of crack indications. Upscale deflections are not significant.

(4) Move probe back and forth to determine if situations above exists. When probe is near edge of part, balance point will move down scale. Return needle to 250 microamperes with Balance control.

(5) Move probe back and forth in suspected area of cracks, and mark area where needle deflection is at least large as variation received during probe movement on reference standard surface.

(6) Mark part surface at crack indication with tube type marker.

8. **FLAW GATE OPERATION WITH FLAW DETECTOR.**

a. Do flaw detector setup paragraph 5.

b. Attach flaw gate to tester.

c. Allow 5 minutes warmup.

NOTE

Operation of flaw detector from internal batteries is recommended for best flaw gate performance.

d. Turn flaw gate MOM./HOLD switch to MOM. This switch position will set flaw gate to alarm only when probe is directly over crack. HOLD will allow continuous alarm which is turned off by pressing RESET.

e. Set UP/DOWN ALARM trigger, as required. For example; cracks in aluminum or magnesium give downscale needle deflections and require DOWN ALARM position.

f. Place probe on reference standard or material being inspected. Meter needle should be approximately 250 microamperes. For downscale crack response, typical alarm point would be 200 microamperes when inspection is done with meter reading of 250 microamperes.

g. Use Balance to set meter needle at 200 microamperes.

h. Adjust flaw gate ALARM POINT so indicator lamp glows slightly.

(1) If lamp is on; turn ALARM POINT counterclockwise.

(2) If lamp is not on; turn ALARM POINT clockwise.

(3) Test alarm point response by adjusting BALANCE back to 250 microamperes and then reducing BALANCE level back to 150 microamperes. Alarm should respond at 200 microamperes, if not repeat step g.

(4) Reset meter needle to 250 microamperes with BALANCE.

(5) Turn AUDIO ON.

(6) Do inspection.

NOTE

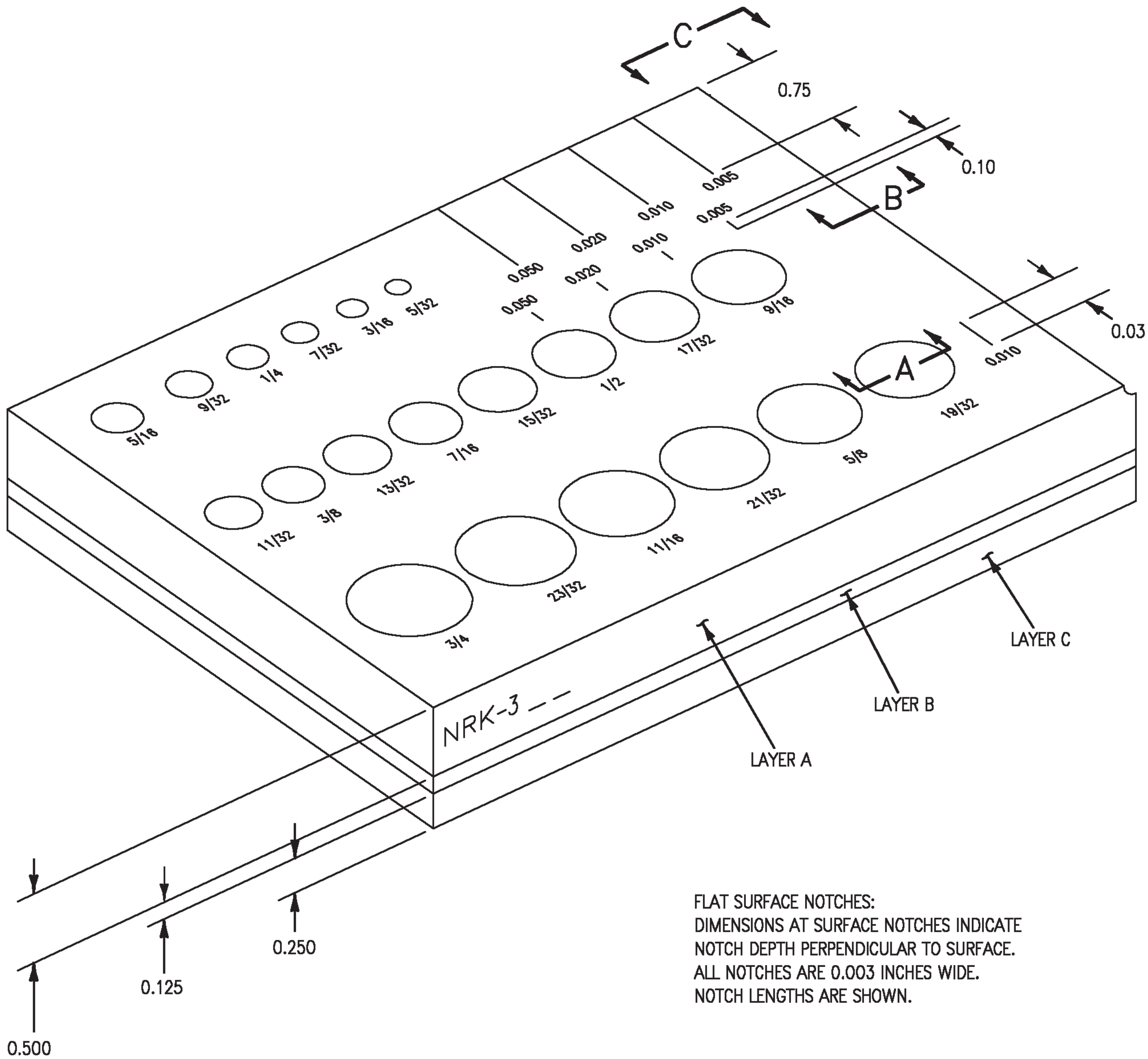
Test for correct control alarm point if tester sensitivity is readjusted. Changes to FUNC will change alarm point on flaw gate.

(7) With correct control settings on tester and flaw gate, be sure flaw gate alarm responds correctly when probe passes over 0.020 inch deep by at least 0.2 inch long EDM notch on reference standard

(8) Verify alarm point every 10 minutes.

i. Mark all crack indications on part with tube type marker.

j. Record direction and size of crack..



NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-3AL ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

MAJOR CHANGE

18AC-SRM-30-(14-1)36-CATI

Figure 1. NRK-3AST Eddy Current Reference Standards

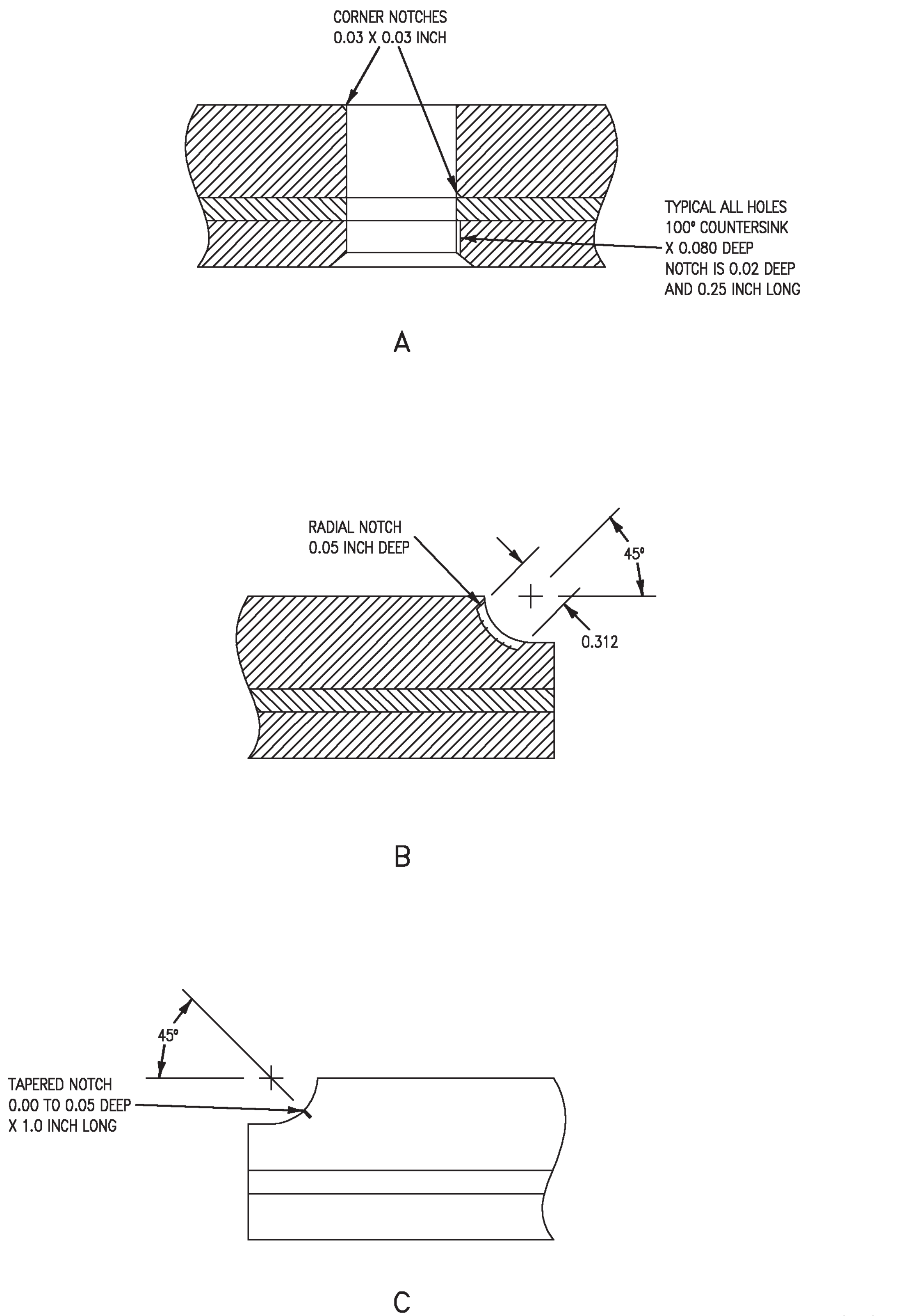


Figure 1. NRK-3AST Eddy Current Reference Standards

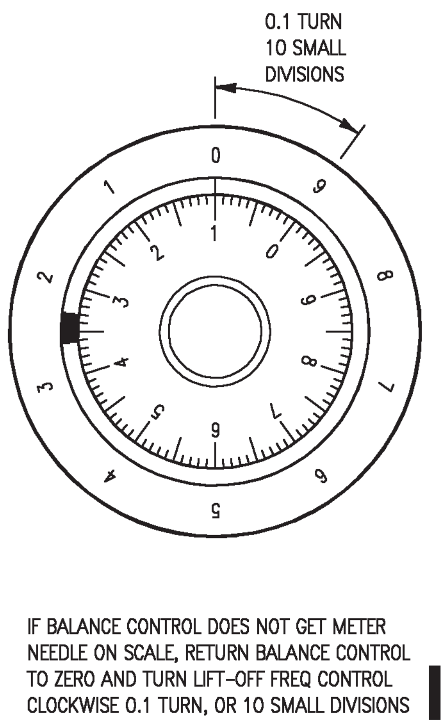


Figure 2. Lift-Off/Freq Control

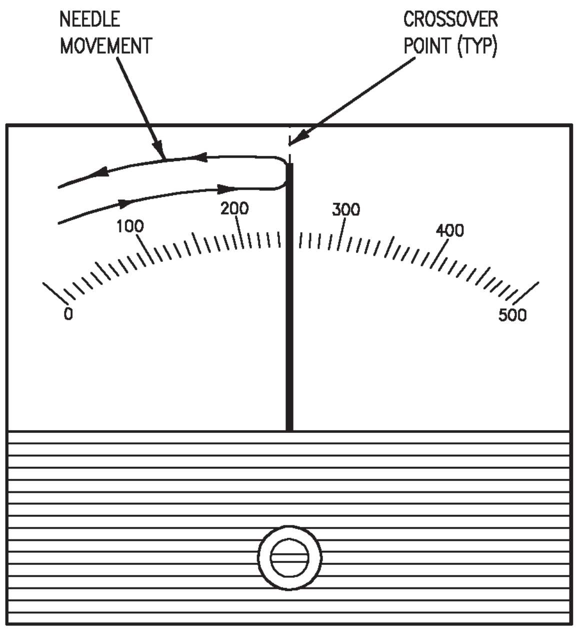


Figure 3. Crossover Point

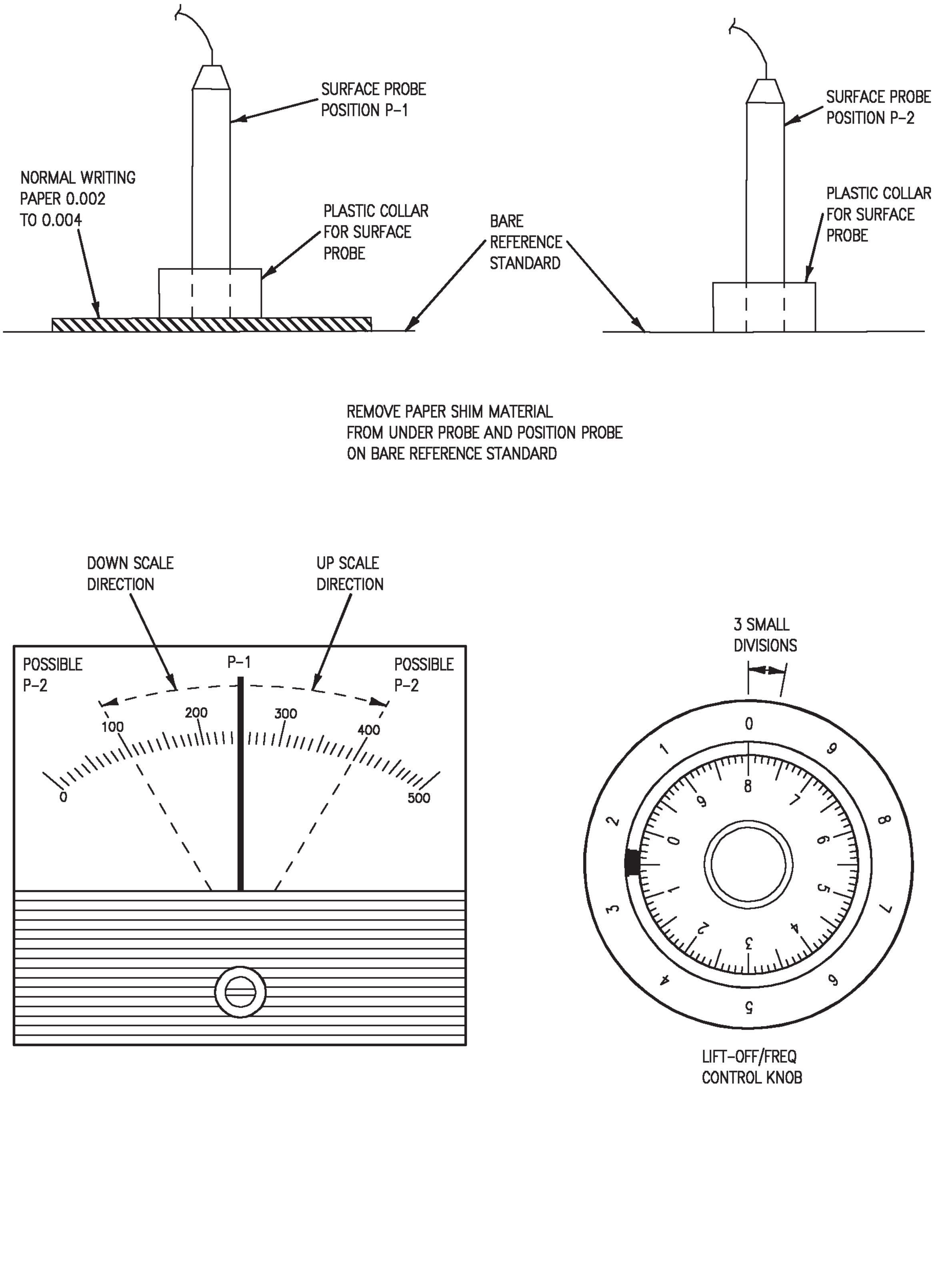
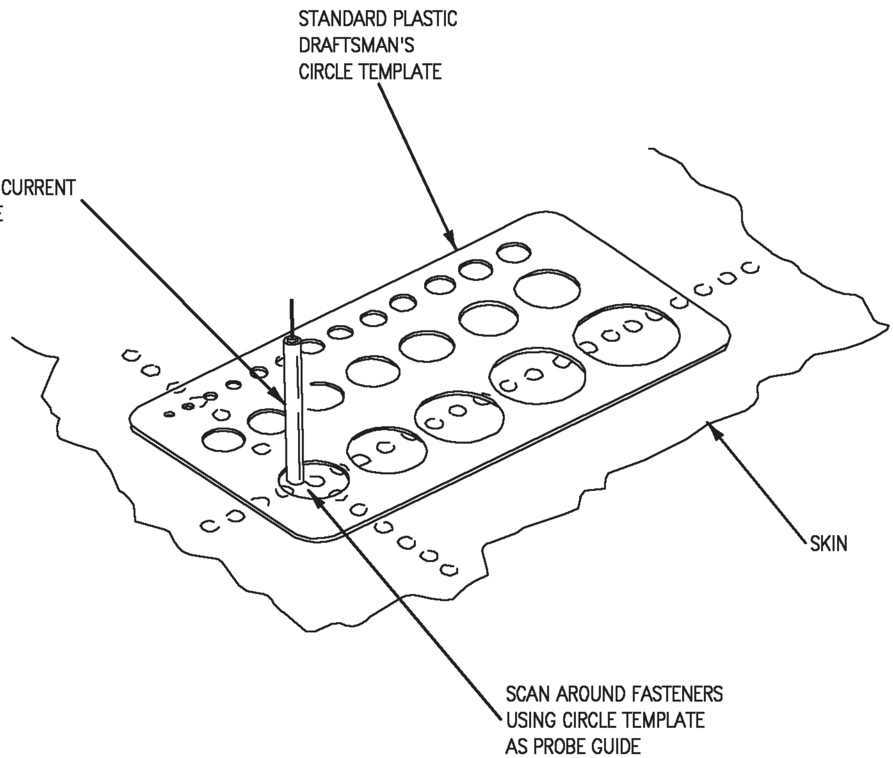
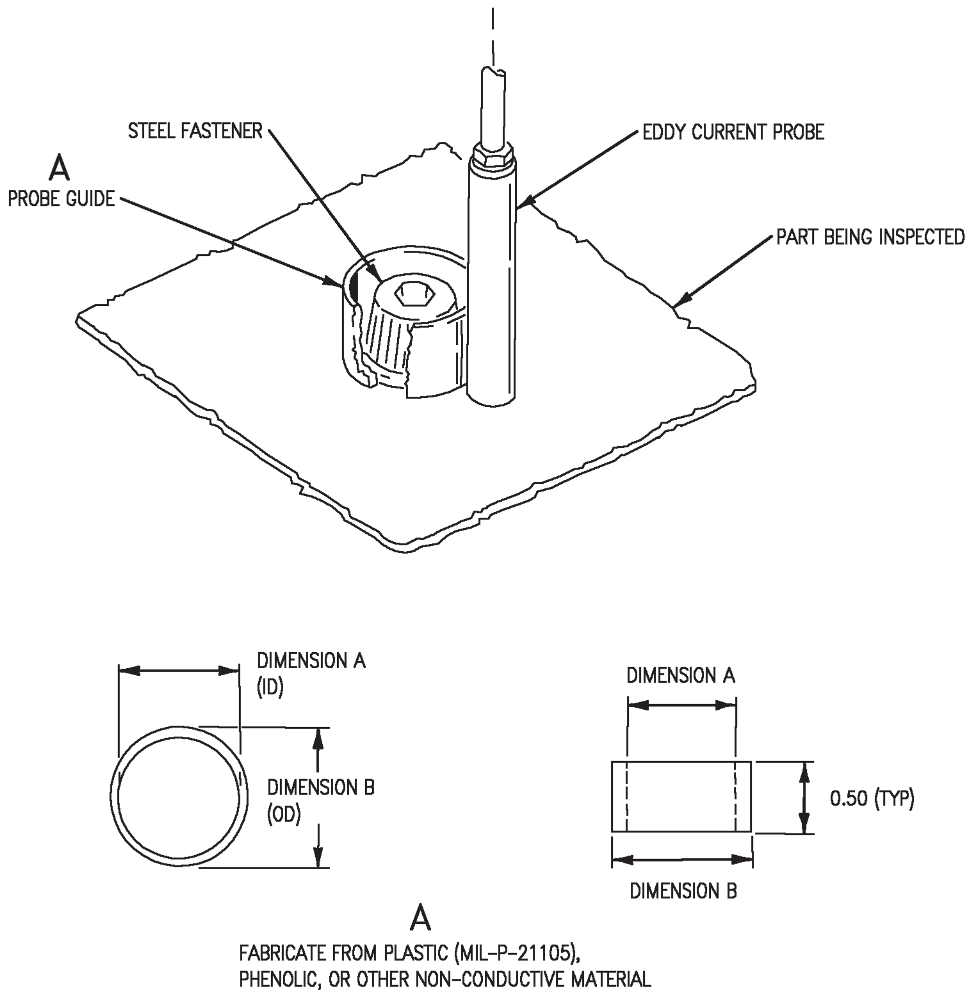


Figure 4. Typical Set-up Responses



18AC-SRM-30-(18-1)36-SCAN

Figure 5. Eddy Current Scanning Around Fasteners Using Circle Template as Probe Guide



LEGEND

ID=INSIDE DIMENSION

OD=OUTSIDE DIMENSION

PROBE GUIDE DIMENSIONS	
DIMENSION A (ID) INCHES	DIMENSION B (OD) INCHES
0.250	0.40
0.3125	0.46
0.375	0.52
0.4375	0.58
0.500	0.65
0.5625	0.71
0.6250	0.77
0.6875	0.83
0.750	0.90

18AC-SRM-30-(19-1)SCAN

Figure 6. Eddy Current Probe Guides for Steel Fasteners

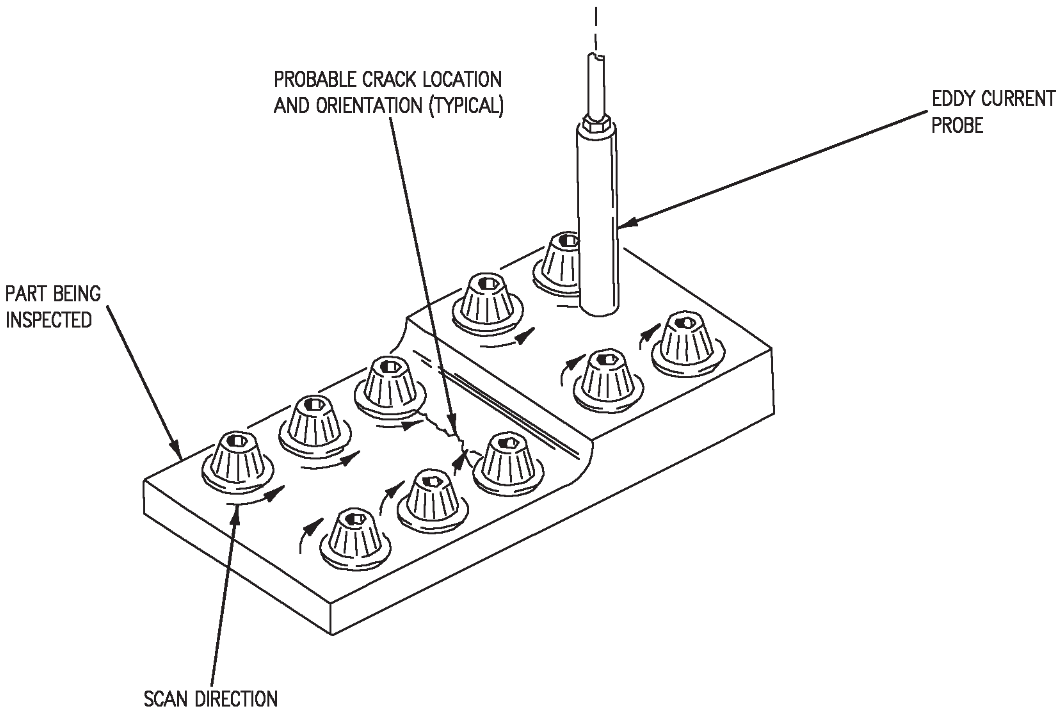


Figure 7. Eddy Current Scanning Between Fasteners

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT HOLE INSPECTION OF ALUMINUM ALLOYS

This WP supersedes WP007 01, dated 1 December 1992.

Reference Material

Plane Captain Manual A1-F18AC-PCM-000
Naval Aviation Maintenance Program .... OPNAVINST 4790.2

Alphabetical Index

Record of Applicable Technical Directives

None

1. **EDDY CURRENT HOLE INSPECTION.**

2. This work package defines safety precautions, surface preparation, eddy current flaw detector (tester) setup, and procedure for doing hole inspections in aluminum and aluminum alloys.

3. **SAFETY PRECAUTIONS.** Make sure safety precautions have been met for electrical, static, grounding when using electrical equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Reference standard is considered equivalent for hole inspection if it is made of same base material with similar diameter holes as part to be inspected Holes should contain 0.030 X 0.030 inch corner EDM radial notch, radial notch 0.010 to 0.020 inch deep and be at least 0.2 inches long. Notch widths must be from 0.002 to 0.005 inches wide. Notches must be separated so they do not effect field produced by probe coil simultaneously.

Part Number or Type Designation	Nomenclature
ED520 (EC 5000)	Eddy Current Flaw Detector, Magnatest or Parker Instru ments
NRK-3AST or EQUIVALENT	Navy Reference Standard Kit, NDI Engineering Corp.
FG1	Flaw Gate, GK Engineering Corp.
GPK-36/FA-18	Navy Eddy Current Probe Kit, NDT Engineering Corp.
COMMERCIAL	Scale, Ruler

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
GENERIC	Any cleaning solvent locally approved for use and acceptable per local environmental regulations.

Materials Required (Continued)

Specification or Part Number	Nomenclature
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
673T	Tube Type Marker

5. **FLAW DETECTOR SETUP.**

a. Connect tester to power supply or use batteries. If batteries are used, test for correct charge. Needle should be above red line on meter scale and not drift down scale during 15 second test. Recharge batteries if required.

b. Connect probe, specified in specific procedure work package or selected from probe kit, to tester. See table 1. If collar is used, align centerline of set screw in collar with centerline of coil for use later in establishing direction of coil when it is in hole.

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit.

Probe P/N	Frequency	Description
MP-30	200 kHz	F.S., Straight Shaft, 1/8 Inch Dia., 3 Inches Long
MP475-50C	200 kHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip
MP9003-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.03 Inch Drop
MP902-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.2 Inch Drop

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP9003-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.3 Inch Drop
MP902-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.2 Inch Drop
MP905-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.5 Inch Drop
MP9003-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.3 Inch Drop
MP902-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.2 Inch Drop
MP905-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.5 Inch Drop
MP-60FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 3 Inches Long,
MP-100FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 10 Inches Long,

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP902-60FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 6 Inches Long, 0.2 Inch Drop
MP902-100FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 10 Inches Long, 0.2 Inch Drop
TPF-902-	200 kHz	Finger Tip Probe, F.S., 1/8 Inch Dia., 90 Degree, 0.2 Inch Drop
AR4C-F/A18	200 kHz	Array Probe, 4 Coil Absolute, 1/2 Inch Wide, Unshielded
MP-30/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., Straight, 3 Inches Long
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip
MP-9003-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.03 Inch Drop
MP902-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.02 Inch Drop

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP-905-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.05 Inch Drop
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Drop
Notes: 1. F.S. =Ferrite Shielded.		

c. Turn FUNCTION to LO.

d. Turn SENSITIVITY INC to MINIMUM, fully counterclockwise.

e. Turn LIFT-OFF/FREQ and BALANCE to ZERO, fully counterclockwise.

f. Position probe in applicable hole of NRK-3AL reference standard, which is part of NRK-3AST Navy Reference standard kit, see figure 1. Make sure probe is not over any EDM notch.

g. Set meter needle on scale by adjusting BALANCE.

h. If balance does not locate meter needle on scale, return BALANCE to ZERO and turn LIFT-OFF/FREQ clockwise 0.1 turn or 10 small divisions, repeat step g, and see figure 2.

i. If required, repeat step h to get meter needle on scale.

NOTE

Direction of needle deflection is critical for correct setup. Make sure following steps are read completely and carefully before making control adjustments.

j. Slowly turn LIFT-OFF/FREQ clockwise observing needle movement direction. Clockwise rotation of this control may cause upscale, downscale, or possibly offscale, deflection of meter needle. For initial downscale deflection of needle , continue slow clockwise rotation of LIFT-OFF/FREQ until upscale needle deflection is observed. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

k. Continue slow clockwise rotation of LIFT-OFF/FREQ until meter needle movement changes from upscale to downscale. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

NOTE

Correct crossover point is indicated by meter needle movement up, then down scale while turning LIFT-OFF/FREQ clockwise, see figure 3.

l. After getting correct crossover point, decrease LIFT-OFF/FREQ 0.2 turn, 20 small divisions, counterclockwise for non-shielded probes or 0.4 turn, 40 small divisions, for ferrite shielded probes.

NOTE

Tester should be set near 0.003 inch lift-off compensation. Confirm lift-off compensation by producing zero needle deflection or same meter indication with or without paper shim between probe and reference standard.

m. Put sheet of paper, 0.002 to 0.004 inch thick, measure with thickness gage, between probe and hole wall, reference standard. See figure 4.

n. Using BALANCE, adjust meter needle to approximately 250 microamperes.

o. Remove paper from between probe and hole wall and observe direction and amount of meter needle deflection. See figure 4.

(1) For downscale needle deflection or off scale downward deflection, when probe is in hole against bare metal, adjust LIFT-OFF/FREQ 1/2-to 10 small divisions counterclockwise.

(2) For upscale needle deflection or off scale upward deflection, when probe is in hole against bare metal, adjust LIFT-OFF/FREQ 1/2-to 10 small divisions clockwise.

p. After any adjustments to LIFT-OFF/FREQ, position 0.002 to 0.004 inch thick paper between probe and reference standard. Use BALANCE to set meter needle at 250 microamperes.

q. Repeat steps m through p using larger or smaller amounts of LIFT-OFF/FREQ or until there is no needle deflection when probe is placed on reference standard, with and without paper.

r. Lock LIFT-OFF/FREQ. Tester is adjusted for lift-off compensation.

s. Sensitivity adjustment for hole inspection.

(1) Select FUNC mode specified in specific procedure work package to get required inspection sensitivity. If FUNC mode is not specified, set FUNC mode on HI.

(2) Insert coil part of probe into reference standard hole away from any notch. See figure 1.

(3) Set meter needle on 250 microamperes by adjusting BALANCE.

(4) Pass coil part of probe over 0.020 inch deep notch. Needle deflection about 150 microamperes should be displayed.

(5) If deflection, of meter needle, is not within 20 microamperes of 150, adjust SENSITIVITY INC until deflection is in correct range. If correct range cannot be reached, replace probe or tester.

WARNING

Cleaning solvent is toxic to eyes, skin, and respiratory tract. Skin/eye protection is required. Avoid repeated, prolonged contact. Use only in well ventilated areas.

6. **SURFACE PREPARATION.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

7. **INSPECTION PROCEDURE.**

a. If collar, probe guide, is used, position collar on shank of probe and tighten set screw so coil centerline-to-collar edge distance is equal to hole depth to be inspected. Use scale to measure collar-to-coil centerline distance. Coil centerline should be in same direction as centerline of set screw.

b. Insert probe into hole to be inspected with coil in direction believed to be free of cracks.

c. Use BALANCE to set meter needle at 250 microamperes.

d. Rotate probe in inspection hole at constant rate, no greater than rotation speed used to get EDM notch response in reference standard. Preferably, only change finger position on probe when coil is located in direction about 90 degrees from direction of suspected crack(s).

NOTE

Scratches in hole may cause meter deflections. Generally, these deflections will not be sharply defined as responses from cracks and may cause upscale and downscale deflections.

e. Rotate probe back and forth with probe coil aligned with suspected direction of cracks.

f. Mark surface, with tube type marker, in direction of set screw centerline where meter needle deflection is at least large as variation made by EDM notch during probe movement in reference standarde hole.

g. Mark part surface at crack indication with tube type marker.

h. Reset coil centerline depth in increments of 1/16 inch and repeat steps b. through g. until full depth of hole is inspected. When more than one hole, with same diameter, is to be inspected, inspect all holes at one depth before repositioning probe in collar for next depth of inspection.

i. When probe is near edge of part, balance point will move down scale. Return needle to 250 microamperes with BALANCE control.

j. If crack is detected, move probe up and down in hole, in direction of maximum deflection, to determine range of depth effected, crack length.

k. Mark probe shank with tube type marker, at hole surface, at each end of crack.

l. Use scale to measure distance between marks, to determine crack length.

m. Mark all crack indications on part, with tube type marker.

n. Record crack direction, microampere difference between crack and background at each depth flaw was detected, and depths in hole where crack was detected.

8. **FLAW GATE OPERATION WITH FLAW DETECTOR.**

a. Do flaw detector setup.

b. Connect flaw gate to tester.

c. Allow 5 minutes warmup.

NOTE

Operation of flaw detector from internal batteries is recommended for optimum flaw gate performance.

d. Turn flaw gate MOM./HOLD to MOM. This switch position will set flaw gate to alarm only when probe is directly over crack. HOLD will sound continuous alarm which is turned off by pressing RESET.

e. Set UP/DOWN ALARM trigger, as required. For example; cracks in aluminum give down scale meter deflections and require DOWN ALARM position.

f. Position probe in hole in reference standard or material being inspected. Meter needle should be approximately 250 microamperes. For down scale crack response, typical alarm point would be 200 microamperes when inspection is done with meter reading of 250 microamperes.

g. Use BALANCE to set meter needle at 200 microamperes.

h. Adjust flaw gate ALARM POINT so indicator lamp glows slightly.

(1) If lamp is on; turn ALARM POINT counterclockwise.

(2) If lamp is not on; turn ALARM POINT clockwise.

(3) Test alarm point response by adjusting BALANCE back to 250 microamperes and then reducing BALANCE level back to 150 microamperes. Alarm should respond at 200 microamperes, if not repeat step g.

i. Reset meter needle to 250 microamperes with BALANCE.

j. Turn AUDIO ON.

k. Do inspection per paragraph 7.

NOTE

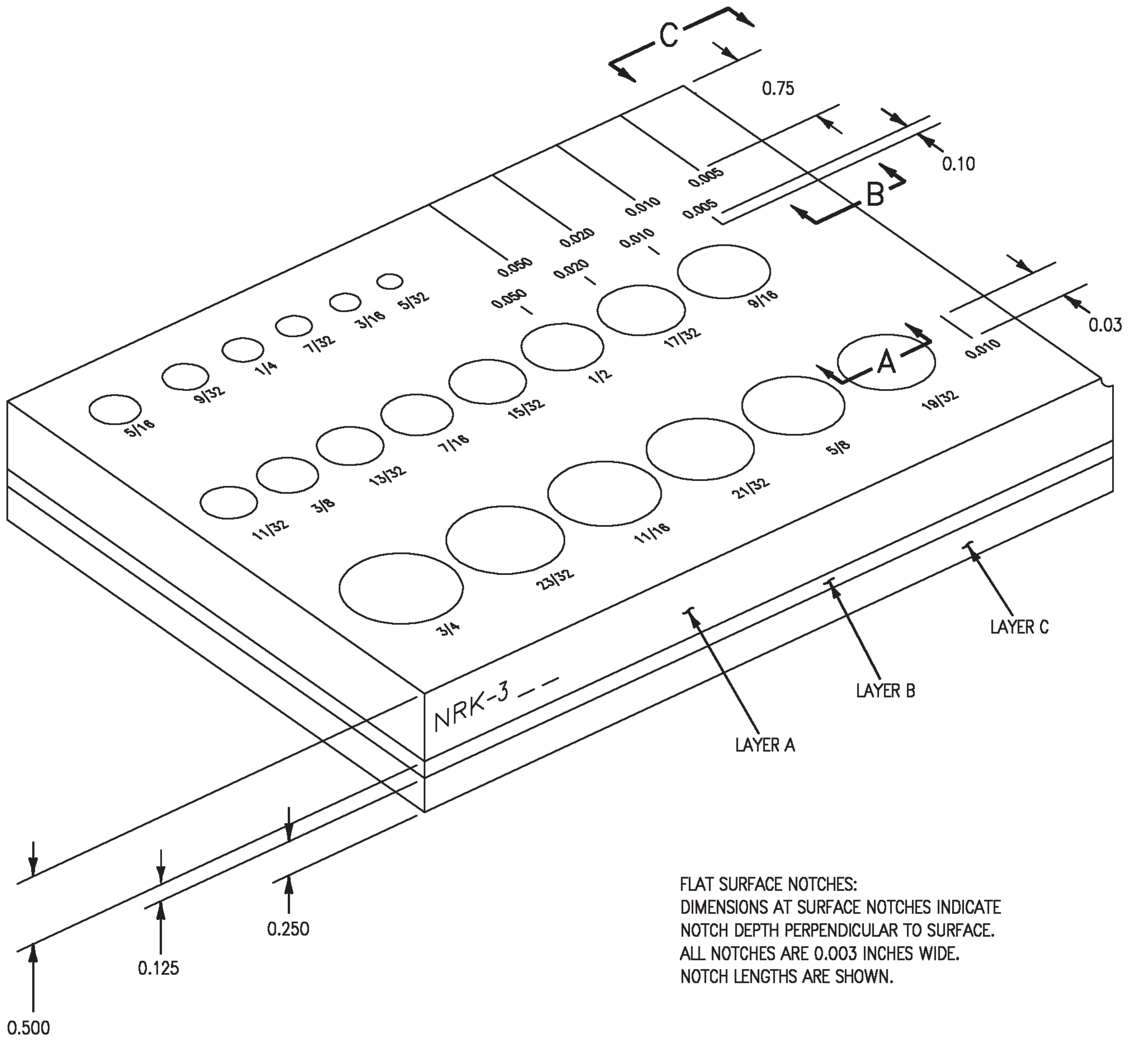
Test for correct alarm point if tester sensitivity is readjusted. Changes to FUNC will change alarm point on flaw gate.

(1) With correct control settings on tester and flaw gate, be sure flaw gate alarm responds correctly when probe passes over EDM 0.020 inch deep by at least 0.2 inch long notch in reference standard.

(2) Verify alarm point every 10 minutes.

l. Mark all crack indications on part with tube type marker.

m. Record direction and depths in hole where crack is detected.



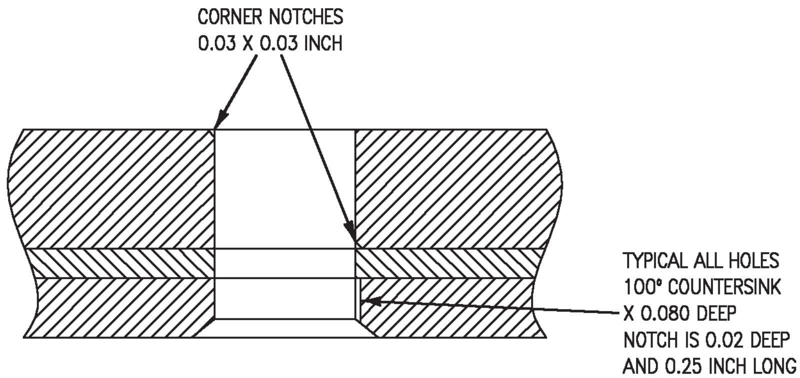
NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-3AL ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

MAJOR CHANGE

18AC-SRM-30-(21-1)36-CATI

Figure 1. Eddy Current Reference Standard (Sheet 1)



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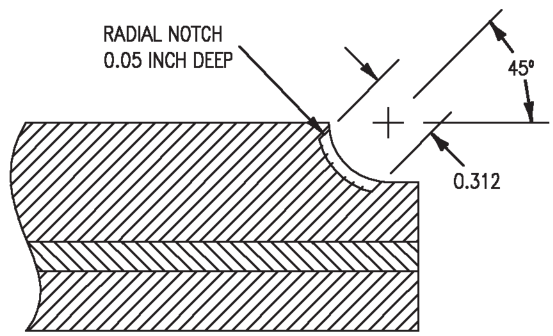

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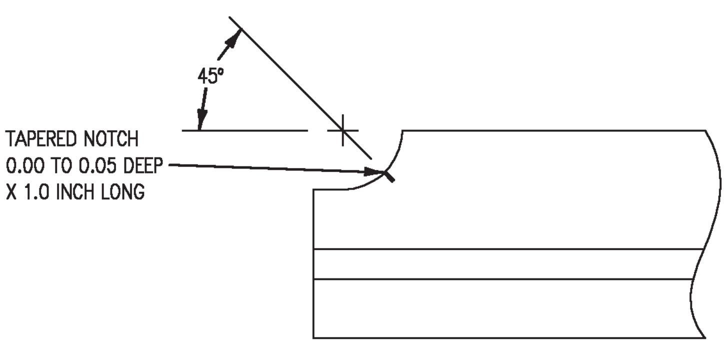
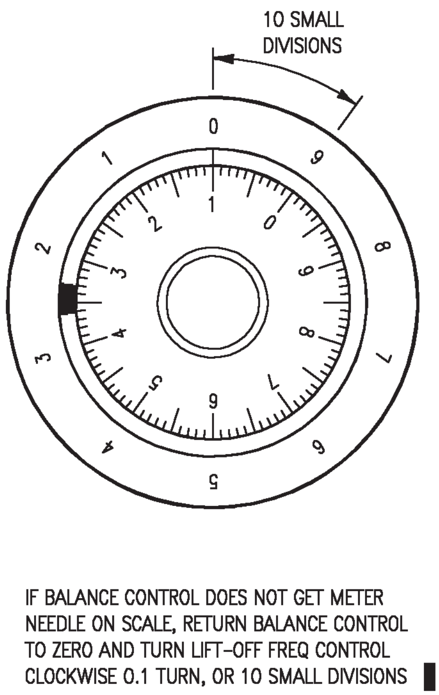


C

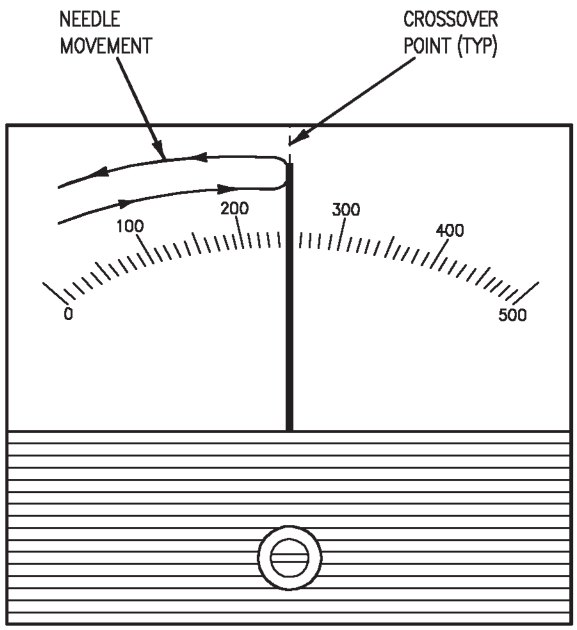
18AC-SRM-30-(21-2)36-CATI

Figure 1. Eddy Current Reference Standard (Sheet 2)



18AC-SRM-30-(22-1)36-SCAN

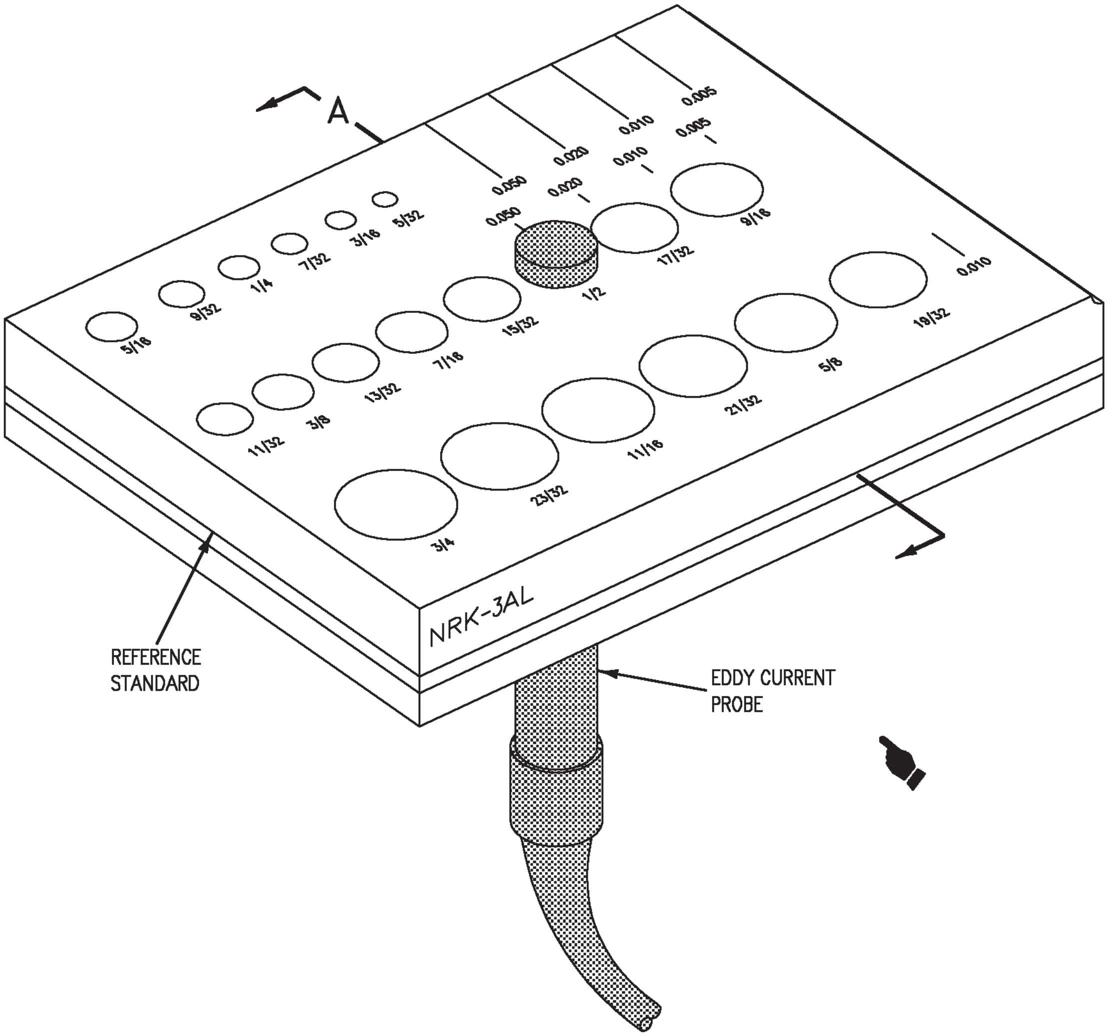
Figure 2. Lift-Off/Freq Control



AT CORRECT CROSSOVER POINT, NEEDLE WILL MOVE UP SCALE, THEN DOWN SCALE WHILE TURNING LIFT-OFF/FREQ CONTROL CLOCKWISE.

18AC-SRM-30-(23-1)26-SCAN

Figure 3. Crossover Point



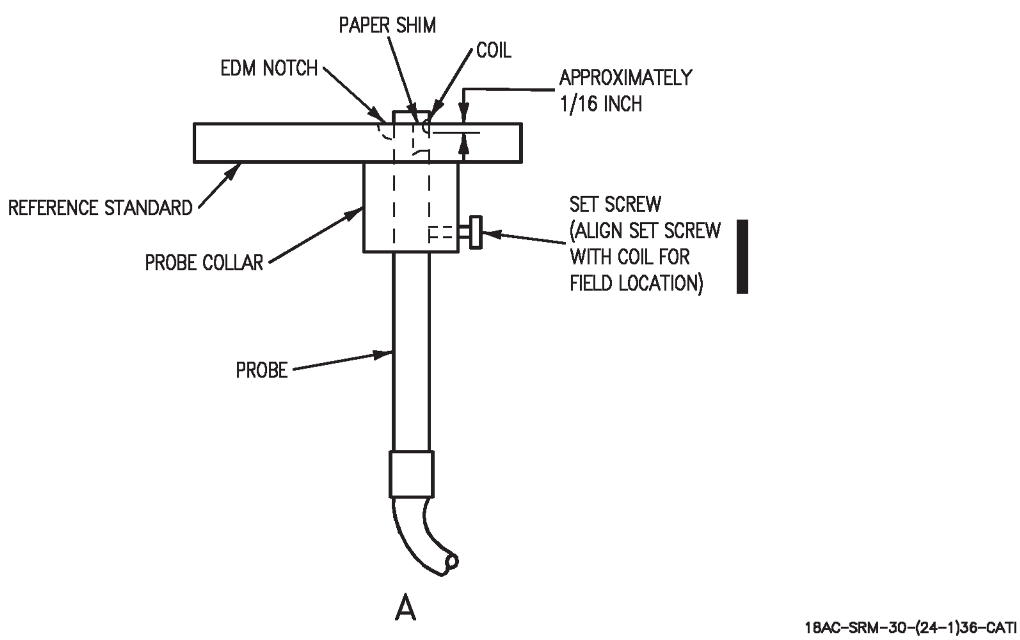
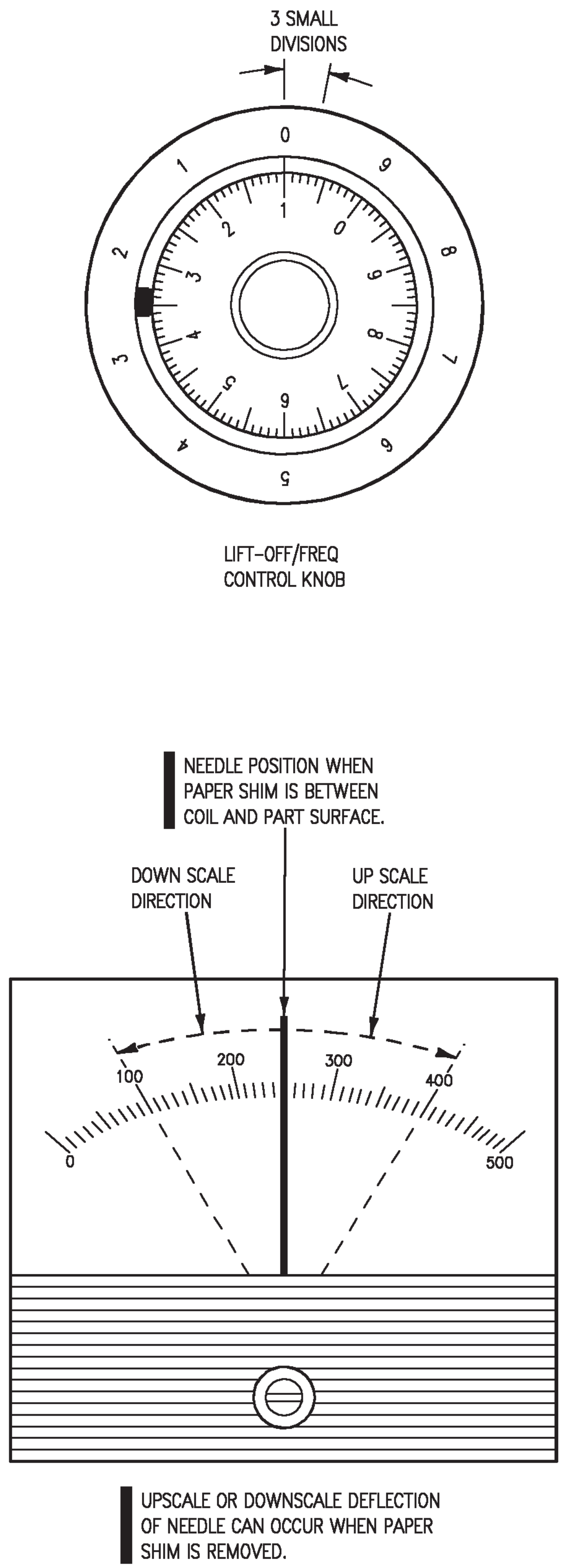


Figure 4. Setup (Sheet 1)



18AC-SRM-30-(24-2)36-CATI

Figure 4. Setup (Sheet 2)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT CRACK EVALUATION OF 0.125 TO 0.375 INCH DIAMETER HOLES IN ALUMINUM ALLOYS

This WP supersedes WP007 02, dated 15 October 1993.

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Naval Aviation Maintenance Program	OPNAVINST 4790.2

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. This work package defines safety precautions, surface preparation, eddy current flaw detector (tester) set up, and procedures for doing eddy current crack evaluation of 0.125 to 0.375 inch diameter holes in aluminum alloys. Crack depth estimation using criteria in table 1 is only applicable to setup listed in this work package using ED520 with 64900 E/C STD for 0.125 to 0.375 inch diameter holes in aluminum alloys.

3. **SAFETY PRECAUTIONS.** Make sure safety precautions have been met for electrical, static, grounding when using electrical equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Reference standard is considered equivalent if it is made of same base material with similar diameter holes as test part and has either 0.030 X 0.030 corner notch or through-the-thickness notch between 0.010 and 0.020.

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnaflux Corporation
NRK-3AST (64900 E/ CSTD (64901 E / CSTD)	Navy Reference Standard Kit

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
GENERIC	Any cleaning solvent locally approved for use and acceptable per local environ mental regulations.
CCC-C-46, TYPE1, CLASS 4	Cleaning Cloth

5. **ED520 FLAW DETECTOR SETUP FOR CRACK SIZE, EVALUATION OF HOLES.**

a. Connect tester to power supply or use batteries. If batteries are used, test for correct charge. Needle should be above red line on meter scale and not drift down scale during 15 second test. Recharge batteries, if required.

b. Connect probe, used in specific procedure work package, to tester.

c. Turn FUNCTION to LOW.

d. Turn SENSITIVITY INC to MINIMUM, fully counterclockwise.

e. Turn LIFT-OFF/FREQ and BALANCE to ZERO, fully counterclockwise.

f. Position probe in designated hole of NRK-3AL reference standard, which is part of NRK-3AST Navy reference standard kit see figure 1.

g. Set meter pointer on scale by adjusting BALANCE.

h. If balance does not locate meter needle on scale, return BALANCE to ZERO and turn LIFT-OFF/FREQ clockwise 0.1 turn or 10 small divisions, repeat step g, and see figure 2.

i. If required, repeat step h to get meter needle on scale.

NOTE

Direction of needle deflection is critical to correct setup. Make sure following steps are read completely and carefully before making control adjustments.

j. Slowly turn LIFT-OFF/FREQ clockwise observing needle movement direction. Clockwise rotation of this control may cause upscale, downscale, or possibly offscale, deflection of meter needle. For initial downscale deflection, continue slow clockwise rotation of LIFT-OFF/FREQ until upscale needle deflection is observed. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

k. Continue slow clockwise rotation of LIFT-OFF/FREQ until meter needle movement changes from upscale to downscale. Adjust BALANCE simultaneously with LIFT-OFF/FREQ to keep meter needle on scale.

NOTE

To get correct crossover point, meter needle must move up then down scale while adjusting LIFT-OFF/FREQ clockwise, see figure 3.

l. After getting correct crossover point, decrease LIFT-OFF/FREQ 0.2 turn, 20 small divisions,

counterclockwise for non-shielded probes or 0.4 turn, 40 small divisions, for ferrite shielded probes.

NOTE

Tester should now be set near 0.003 inch lift-off compensation. Following setup objective is to confirm lift-off compensation by producting zero needle deflection or same meter indication with or without paper shim between probe and reference standard setup point.

m. Put sheet of paper, 0.002 to 0.004 inch thick, measured with thickness gage, between probe and reference standard, see figure 4.

n. Using BALANCE, adjust meter needle to approximately 250 microamperes.

o. Remove paper from between probe and reference standard, observing direction and amount of meter needle deflection.

(1) For downscale needle deflection or off scale downward deflection, when probe is in hole on bare material, adjust LIFT-OFF/FREQ 1/2 to 10 small divisions counterclockwise.

(2) For upscale needle deflection or off scale upward deflection, when probe is in hole on bare material, adjust LIFT-OFF/FREQ 1/2 to 10 small divisions clockwise.

p. After any adjustments to LIFT-OFF/FREQ position 0.003 paper between probe and reference standard. Use BALANCE to set meter needle at 250 microamperes.

q. Repeat steps m through o using larger or smaller amounts of LIFT-OFF/FREQ or until there is no needle deflection when probe is placed on reference standard, with or without paper.

r. Lock LIFT-OFF/FREQ: Tester is adjusted for 0.003 inch lift-off compensation.

s. Sensitivity adjustment for hole inspection.

(1) Turn FUNCTION to HI.

(2) Insert probe into reference standard hole.

(3) Position probe collar to align coil approximately in center of layer A, see figure 1, keeping coil away from EDM notch and thin areas of reference standard, see figure 4.

(4) Position probe in hole so coil is centered in layer A.

(5) Set meter needle on 300 microamperes by adjusting BALANCE.

(6) Position probe collar to align probe coil approximately in center of layer C, see figure 1, away from EDM notch and thin areas of reference standard, see figure 4. Meter needle should now have different position than in substep (5). Difference in substeps (5) and (6) readings should equal 30 to 34 times difference in conductivity between layers A and C of reference standard.

(7) If meter needle indication is 10 microamperes below or above microamperes determined in substep (6), adjust meter needle deflection with SENSITIVITY INC to correct microamperes difference.

WARNING

Cleaning solvent is toxic to eyes, skin, and respiratory tract. Skin/eye protection is required. Avoid repeated, prolonged contact. Use only in well ventilated areas.

6. **SURFACE PREPARATION.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

7. **INSPECTION PROCEDURE.**

a. Insert probe into inspection hole. Inspections made less than 1/8-inch from edge of hole or faying surface to center of probe coil element, may be electronically noisy and difficult to interpret. Interpretations shall not be made when inspecting closer than 1/16-inch from end of hole to center of coil element.

b. Adjust BALANCE to get meter needle to 300 microamperes when probe coil is in hole and as far away from crack as possible..

NOTE

Sharp meter needle movements down scale are characteristic of crack indications. Up scale deflections may not be significant. Probe located near edge of hole may cause needle balance point to move down scale.

c. Crack depth estimation. Cracks in holes in aluminum can be profiled by measuring difference in microampere readings when probe coil is at crack position and when it is at other positions around hole, refer to table 1.

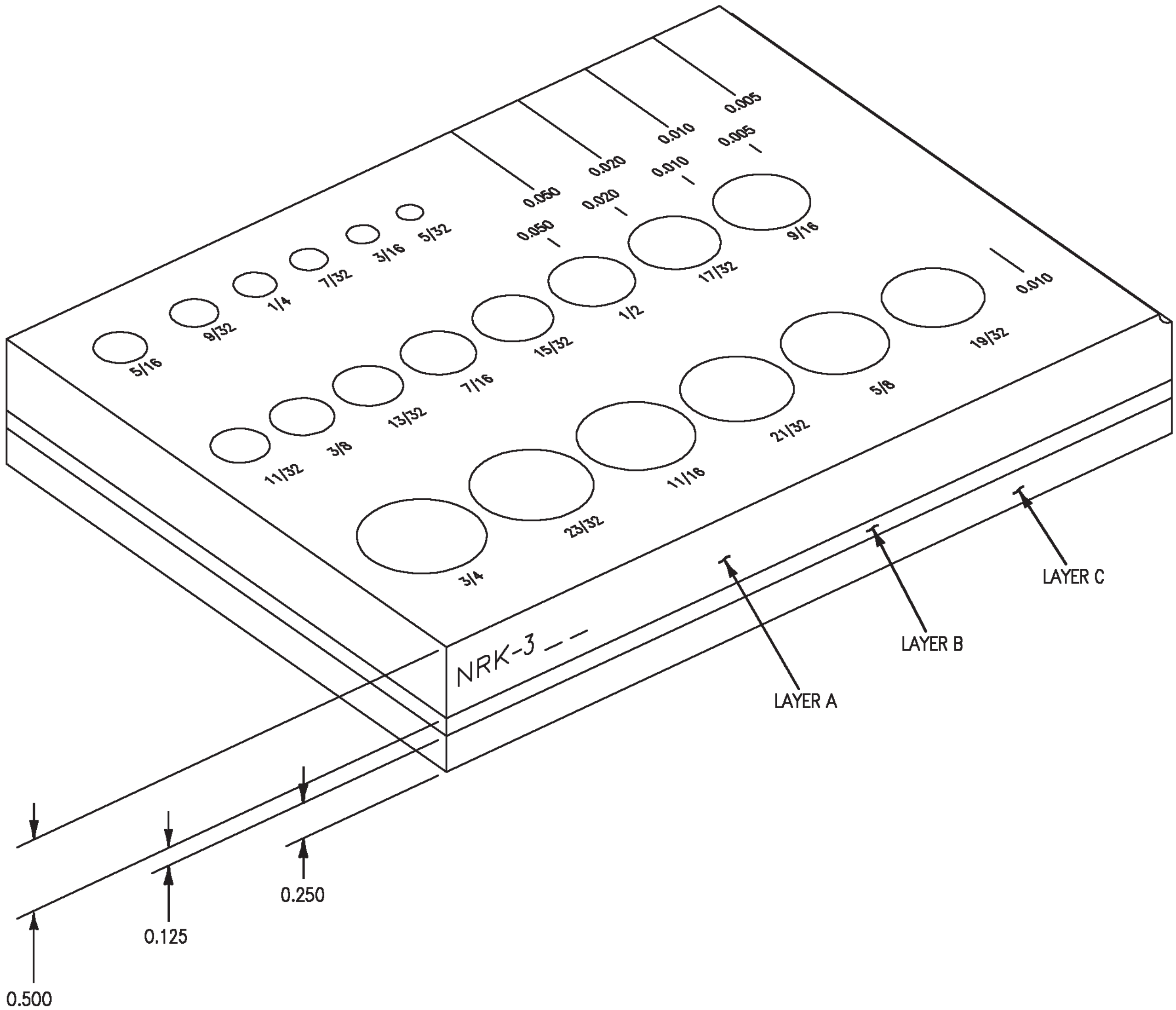
d. Scan for flaws by rotating probe at constant depths at intervals not exceeding 1/16-inch in depth.

e. At each depth in hole reset balance point to 300 microamperes with BALANCE control, when probe coil is as far away from crack as possible. Determine maximum difference in microamperage when probe is at crack and when probe is at other positions around hole. Plotting crack depth verses probe coil depth in hole will yield crack profile for aluminum. Use table 1 for crack depth estimation of aluminum materials only and ED520 tester only, once microampere difference is known.

Table 1. Crack Depth Estimation (Aluminum)

Eddy Current Instrument Response (Microamps)	Fatigue Crack Depth (Mils)
10	4±3
11-13	5±3
14-18	6±3
19-24	7±3
25-30	8±3
31-37	9±3
38-45	10±3
46-55	11±3
56-65	12±3
66-76	13±3
77-86	14±3
87-96	15±3
97-107	16±3
108-117	17±3
118-127	18±3
128-138	19±3
139-148	20±3
149-158	21±3
159-169	22±3
170-179	23±3
180-189	24±4
190-200	25±4
201-210	26±4
211-220	27±4
221-230	28±4
231-241	29±4
242-251	30±5
252-261	31±5
262-272	32±5
273-282	33±5
283-292	34±5
293-302	35±5
303-313	36±5
314-323	37±6
324-333	38±6
334-344	39±6
345-354	40±6
355-364	41±6
365-374	42±6
375-385	43±6
386-395	44±7
396-405	45±7
406-416	46±7
417-426	47±7
427-436	48±7
437-446	49±7
447 AND UP	GREATER THAN 0.050

f. If difference between crack and no crack areas of hole make microampere difference greater than 300 microamperes, set needle position to 400 microamperes or 450 microamperes maximum, when probe coil is in uncracked, good, area of hole. Determine maximum difference in microamperes as probe coil moves across crack. Refer to table 1 to determine crack depth.



NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-3AL ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

18AC-SRM-30-(25-1)36-CATI

Figure 1. Eddy Current Reference Standard

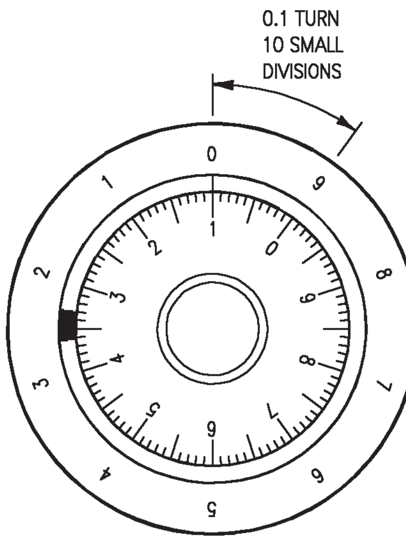
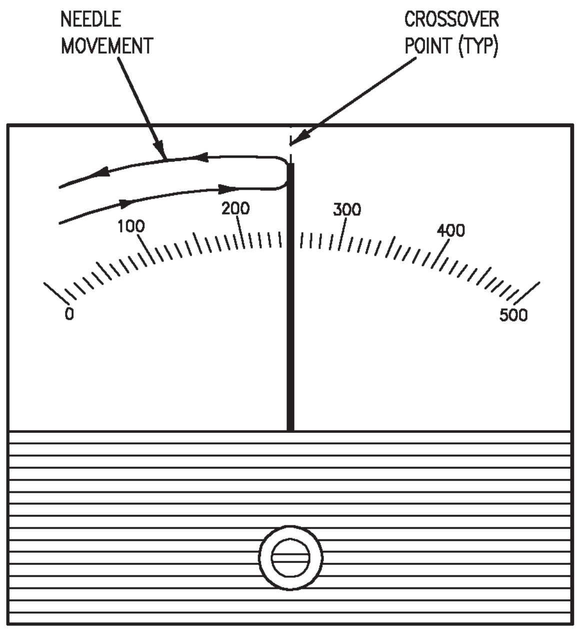


Figure 2. Lift-Off/Freq Control



AT CORRECT CROSSOVER POINT, NEEDLE WILL MOVE UP SCALE, THEN DOWN SCALE WHILE TURNING LIFT-OFF/FREQ CONTROL CLOCKWISE.

18AC-SRM-30-(27-1)-SCAN

Figure 3. Crossover Point

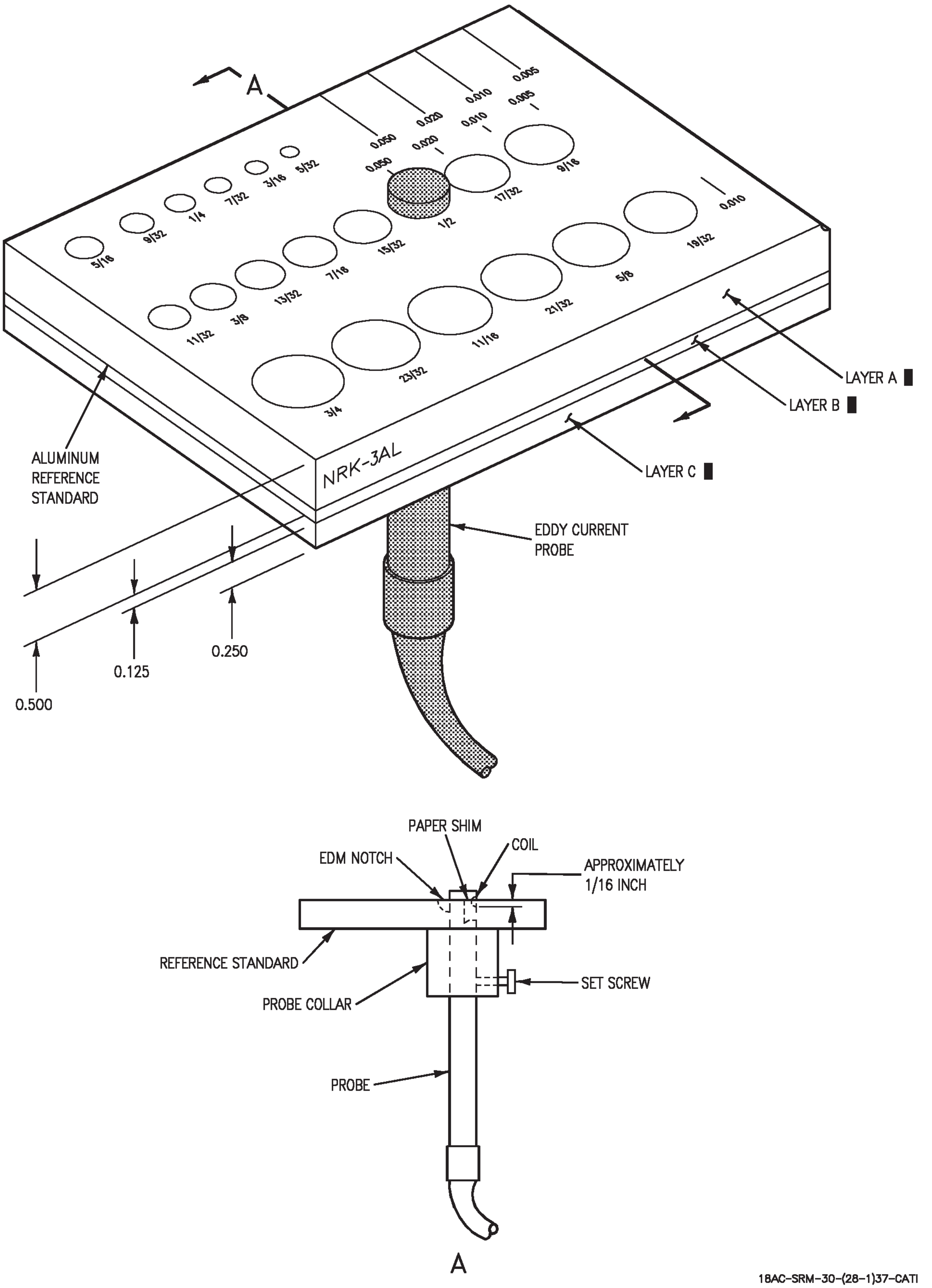
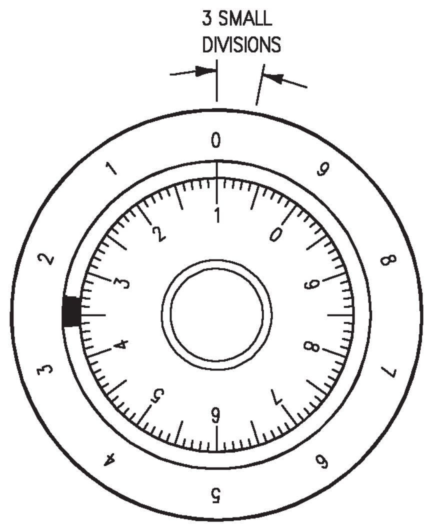
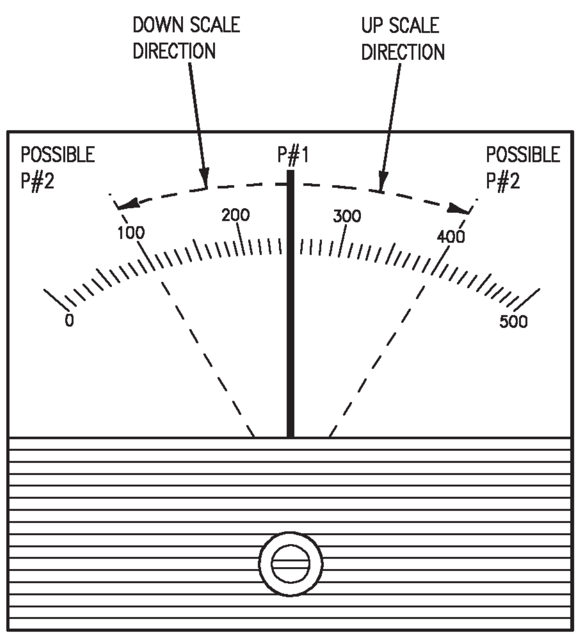


Figure 4. Setup (Sheet 1)





18AC-SRM-30-(28-2)-SCAN

Figure 4. Setup (Sheet 2)

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT SURFACE INSPECTION USING IMPEDANCE PLANE EDDYSCOPE

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. This work package defines safety requirements, support equipment required, surface preparation, materials required, standardization, and inspection procedures using NDT-25N programmable eddyscope or equivalent, for surface crack detection in aluminum, titanium, and magnetic and nonmagnetic steel alloys.

3. **SAFETY REQUIREMENTS.** Make sure safety requirements have been met before using electrical equipment near aircraft fuel cells, oxygen systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS..** Personnel doing this nondestructive inspection shall be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/ MOS 6044.

NOTE

Reference standard is considered equivalent if it is made of same base material as part to be inspected and contains at least two electrical discharge machined (EDM) surface notches between 0.005 and 0.020 inch deep, at least 0.2 inches long, and 0.002 to 0.005 inches wide.

Any impedance plane eddyscope may be used for this procedure in conjection with any absolute shielded or unshielded probe if equipment and probe are standardized similar to paragraph 5. Exact machine settings and terminology may vary, but eddyscope traces should be repeatable. Specific procedure work package should specify probe to be used.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N MXU-713/E	Programmable Eddy scope, Nortec
9505955	NDT-25N Accessory Kit, Nortec
NRK-3AST or EQUIVALENT	Navy Reference Standard Kit, NDI Engineering Corp.
GPK-36 / F/A-18 or EQUIVALENT	Navy Eddy Current Probe Kit, NDI Engineering Corp.
57A2271	Microdot to BNC Connecting Cable
ADN-B1	Probe Adapter, Microdot to 12-Pin, Burndy
COMMERCIAL	Scale, Ruler
COMMERCIAL	Inspection Mirror, Hinged
COMMERCIAL	Hole Template, Draftsman Plastic Circle Template
COMMERCIAL	Flashlight

Materials Required

Specification or Part Number	Nomenclature
GENERIC	Any cleaning solvent approved for use and acceptable per local environmental regulations.
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
673T	Tube Type Marker

5. **STANDARDIZATION OF NDT-25N.**

a. Attach adapter, if required, which is part of accessory kit, to PROBE connection on eddyscope, see figure 1.

NOTE

Some probes require use of additional probe for use as reference coil. For these, probe adapter with two ports will be used and required probes are connected to both ports of adapter. One probe is used for inspection and other probe used as reference coil. Reference coil should remain at same location relative to any conductor during standardization and inspection to maintain NULL.

b. Attach probe, see table 1, to front of adapter and second probe, or reference coil, with approximately same frequency and coil size, to side of adapter. Reference coil must be kept at constant distance from all electrically conductive material during standardization and inspecting.

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit.

Probe P/N	Frequency	Description
MP-30	200 kHz	F.S., Straight Shaft, 1/8 Inch Dia., 3 Inches Long

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP475-50C	200 kHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip
MP9003-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.03 Inch Drop
MP902-50	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 0.2 Inch Drop
MP9003-50B	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.3 Inch Drop
MP902-50B MP905-50B	200 kHz 200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.2 Inch Drop F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft, 0.5 Inch Drop
MP9003-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.3 Inch Drop
MP902-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.2 Inch Drop

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP905-30	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, 3 Inches Long, 0.5 Inch Drop
MP-60FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 3 Inches Long,
MP-100FX	200 kHz	F.S., 1/8 Inch Dia., Straight, Bendable Shaft, 10 Inches Long,
MP902-60FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 6 Inches Long, 0.2 Inch Drop
MP902-100FX	200 kHz	F.S., 1/8 Inch Dia., 90 Degree, Bendable Shaft, 10 Inches Long, 0.2 Inch Drop
TPF-902- AR4C-F/A18	200 kHz 200 kHz	Finger Tip Probe, F.S., 1/8 Inch Dia., 90 Degree, 0.2 Inch Drop Array Probe, 4 Coil Absolute, 1/2 Inch Wide, Unshielded
MP-30/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., Straight, 3 Inches Long
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Tip

Table 1. Eddy Current Surface Probes in GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
MP-9003-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.03 Inch Drop
MP902-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.02 Inch Drop
MP-905-50B/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 90 Degree, 5 Inches Long, 20 Degree Bent Shaft 0.05 Inch Drop
MP452-50C/600K	400 kHz to 1.0 MHz	F.S., 1/8 Inch Dia., 45 Degree, 5 Inches Long, 0.7 Inch Drop
Notes: 1. F.S. =Ferrite Shielded.		

c. If external power is to be used, connect power source to eddyscope power input.

d. Turn eddyscope ON, press ON button.

e. Settings are entered by first pressing button of desired function, existing setting will then be given on digital display.

(1) Existing settings may be changed by pressing up or down directional buttons, indicated by triangular arrow, or by entering in desired setting value on key pad.

(2) Press ENTER. Initial settings should be as follows, and refer to table 2;

POWER........................... ON
STATUS LIGHTS .... ON
H/V .... ON
I/O SWITCHES............ OFF
FILTER........................... 0
ALARM........................... OFF
NON-STORE .... OFF
HORN .... OFF

Table 2. Additional Settings.

	Alu-minum	Tita-nium	Steel	
			Non magnetic	Mag-netic
GAIN	36	44	44	46
FREQ kHz	200	1000	1000	30
H SENS	1	1	1	1
V SENS	0.2	0.2	0.2	0.5

f. Position probe on reference standard away from any engraving, notch, hole, or edge. See figure 2.

g. Press NULL.

h. Press ERASE button.

i. Press POS button.

j. Press directional buttons as indicated by triangular arrow on button until dot is centered on CRT, this is metal point.

k. Press NULL and ERASE buttons in succession, See figure 3, CRT 1.

NOTE

In following steps press ERASE button, as required.

l. Adjust ANGLE, as required, to get trace on CRT similar to trace shown on figure 3, CRT 2, as

probe is lifted off surface of reference standard. This is lift-off trace.

m. Press NULL after each ANGLE adjustment is entered into tester.

n. Scan probe over EDM notches in reference standard indicated in step f. through k. and towards edge of reference standard to illustrate edge effect. Try to maintain constant distance of 1/8 to 1/4-inch from edge of reference standard while scanning over surface notches to minimize edge effect. Traces should appear on CRT similar to those shown on figure 3, CRT 2. If traces are not similar, adjust GAIN and ANGLE until traces are similar. Press NULL after any change(s) to GAIN.

6. **SURFACE PREPARATION.**

a. Visually inspect inspection area (s). Flashlight and mirror may be required. Cracked area(s) may show accumulation of dirt or soot.

WARNING

Cleaning solvent is toxic to eyes, skin, or respiratory tract. Skin/eye protection is required. Avoid repeated/prolonged contact. Use only in well ventilated areas.

b. Clean inspection area with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

7. **INSPECTION PROCEDURE.**

a. Place probe on part near area to be inspected.

b. Press NULL and ERASE buttons, CRT should appear as shown in figure 3, CRT 1.

c. Lift probe off part to determine lift-off direction.

d. Adjust ANGLE, as required, in order to have lift-off trace travel from center of CRT to left as shown in figure 3, CRT 2.

NOTE

Due to variation in conductivity from part-to-part or from reference standard-to-reference standard, trace direction may rotate slightly. Parts less conductive than reference standard will have traces rotated counterclockwise. Parts more conductive than reference standard will have traces rotated slightly clockwise from those traces shown in figure 3, CRT 3.

e. Surface inspection considerations:

(1) Scanning around fasteners;

(a) Use of probe guide, hole template, is recommend to allow spacing between fastener(s) and eddy current probe. Select template hole diameter large enough to make sure probe does not contact fastener, but at same time locates probe close as possible to fastener hole interface. See figure 4. Probe guide spacing prevents generation of crack like response from edge effects or lift-off noise. Both of these indications are related with inspecting to close to steel fasteners in nonferrous parts. Figure 5, shows design and fabrication requirements for one type of probe guide for protruded fasteners. Probe guides are not required when using ferrite shielded probes, but use is recommended.

(b) Scan inspection surfaces by moving probe at constant speed, no greater than speed required to get flaw response on reference standard.

NOTE

Paint thickness variations may cause trace deflections in horizontal direction. Generally these deflections will not be as sharply defined as responses from cracks. Part thickness changes and machined subsurface edges should be marked on surface for comparison reasons. These thickness changes and edges will cause trace deflection sharply defined as cracks. Sharp movements upward on eddyscope are characteristic of crack indications. Downward movements indicate increased conductivity which could be due to increased thickness, substructure, or softer material. See figure 3, CRT 3.

(c) Move probe back and forth to determine if situations above exists. When probe is near edge of part, metal point will move up and to left. Return metal point to original location shown in figure 3, CRTs 1 and 2 by pressing NULL.

(d) Move probe back and forth in suspected crack area.

(e) Mark area, with tube type marker, where trace upward deflection is at least large as deflection received during probe movement across smaller EDM notch in reference standard surface, used during standardization.

(f) Always scan inspection areas parallel to edges and preferably perpendicular to suspected crack directions. For radii, scan down radii with probe centerline on radius. See figure 6.

(g) Index one half coil diameter between scans. When scanning radius, scan at least normal to each tangent to radius and in 45 degree radial direction. See figure 7. Traces similar to those shown in figure 3, CRT 2 will result after nulling. Without nulling, metal point would be lower on eddyscope resulting in slightly clockwise rotation of lift-off trace.

(h) When probe is nulled and standardized on flat surface, trace will tend to move downward and to right as probe enters radius due to increased conductive material in field of coil.

NOTE

Lift-off will always make traces to left. Tapered section will produce gradual upward or downward trace on eddyscope as probe moves from thicker section of part to thinner section of part. See figure 3, CRT 3. Rocking probe can produce trace in lift-off direction, or 180 degrees, opposite of lift-off. See figure 3, CRT 4.

If coil is shorting against part surface, traces which tend to go diagonally across eddyscope can happen at random. See figure 3, CRT 5. Generally all traces will be in one direction. To correct for this condition, position piece of celluloid tape on end of probe and do standardization and inspection with tape in position. Monitor tape condition and replace when hole begins to form in tape. To prevent wear of probe and more consistent measurements, tape should always be used.

(2) Surface conditions must be taken into consideration;

(a) For bare, primed, or primed and painted metal surfaces, position one layer of celluloid tape on tip of probe to cover coil wear, provide for easier scan, and keep probe from shorting to part. If paint is cracked, very irregular in thickness, or tlacking and causes problems in interpreting trace, it should be sanded smooth, otherwise do not sand or remove paint.

(b) For erosion barriers which are often 0.02 to 0.05 inch thick, lift-off compensation must be made using paper or plastic shims of total thickness approximating thickness of particular erosion coating. Place these shims over notches in reference standard during standardization. GAIN will have to be increased and perhaps FREQ decreased to get traces like those shown in figure 3, CRT 2.

(c) For plated parts or parts coated with polymers containing conductors, reference standard used during standardization must be plated or coated with applicable thickness and type material in location of notches. GAIN and FREQ settings will have to be modified to get traces similar to those shown in figure 3, CRT 2.

Reference standards from Navy reference standard kit may not be used for standardization without simulated plating or coating over notches.

(d) Press NULL and ERASE, as required, to keep CRT pattern similar to CRTs shown on figure 3, CRT 2, during scanning. It is acceptable for dot on CRT to travel along lift-off line long as it remains on eddyscope. Rescan any areas in which trace does not appear on eddyscope, being careful to maintain good contact between probe tip and part surface, and minimizing rocking of probe.

(e) Any traces having separation angle from lift-off equal to or greater than trace from shallowest notch in reference standard and upward deflection at least large as shallowest notch, see figure 3, CRT 2, should be marked on part with tube type marker, if indication is repeatable.

(f) Determine crack length by scanning back and forth perpendicular to crack while indexing along crack centerline.

(g) When determining crack length, ends of cracks will be determined when dot returns to original metal point on eddyscope. To verify end of crack, scan from good area into suspected end of crack.

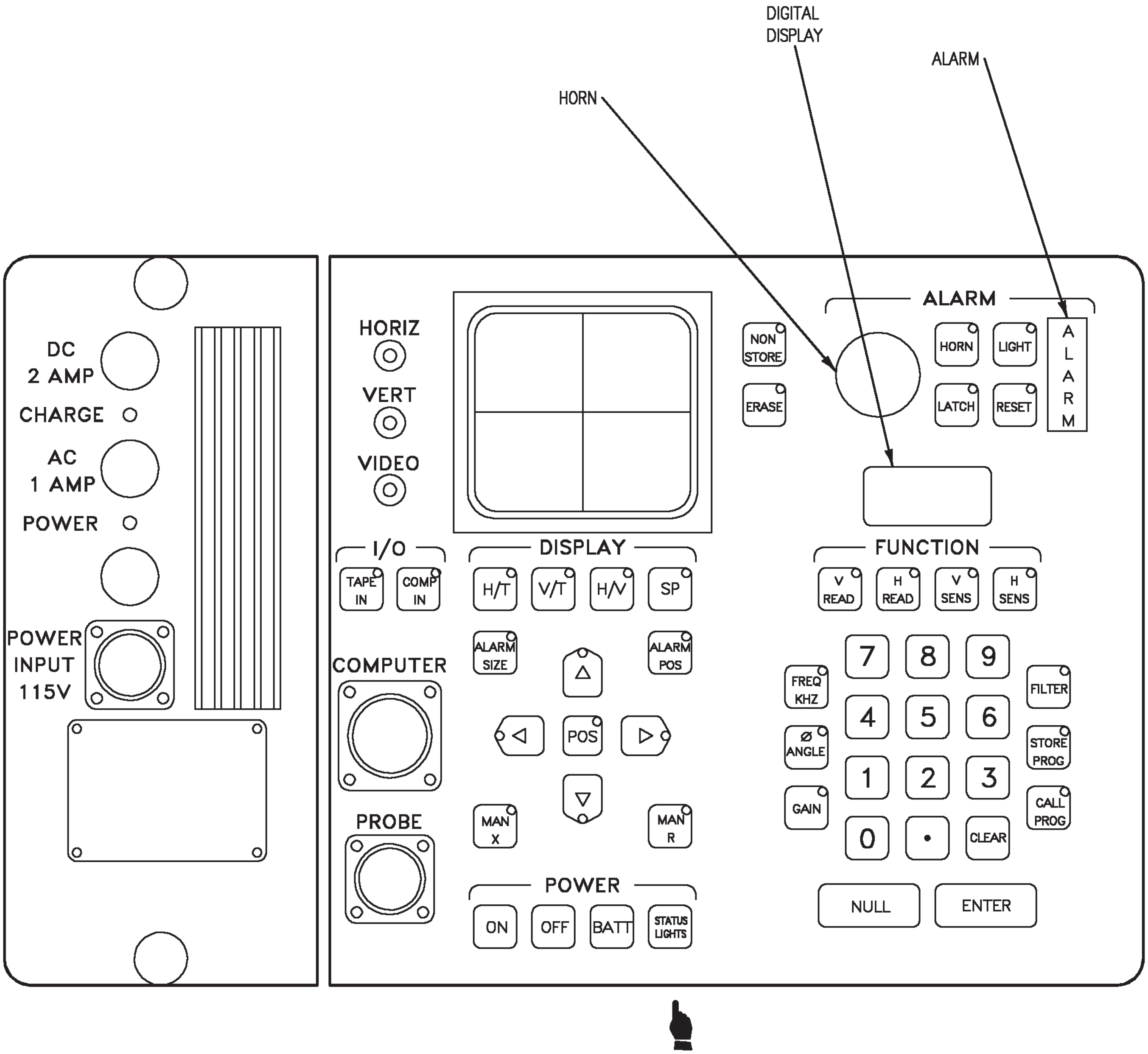
(h) Mark area on part, with tube type marker, at coil centerline, where dot begins to rise above metal point.

8. **ACCEPTANCE LIMITS.** Request engineering disposition for all crack indications.

9. **DOCUMENTATION .**

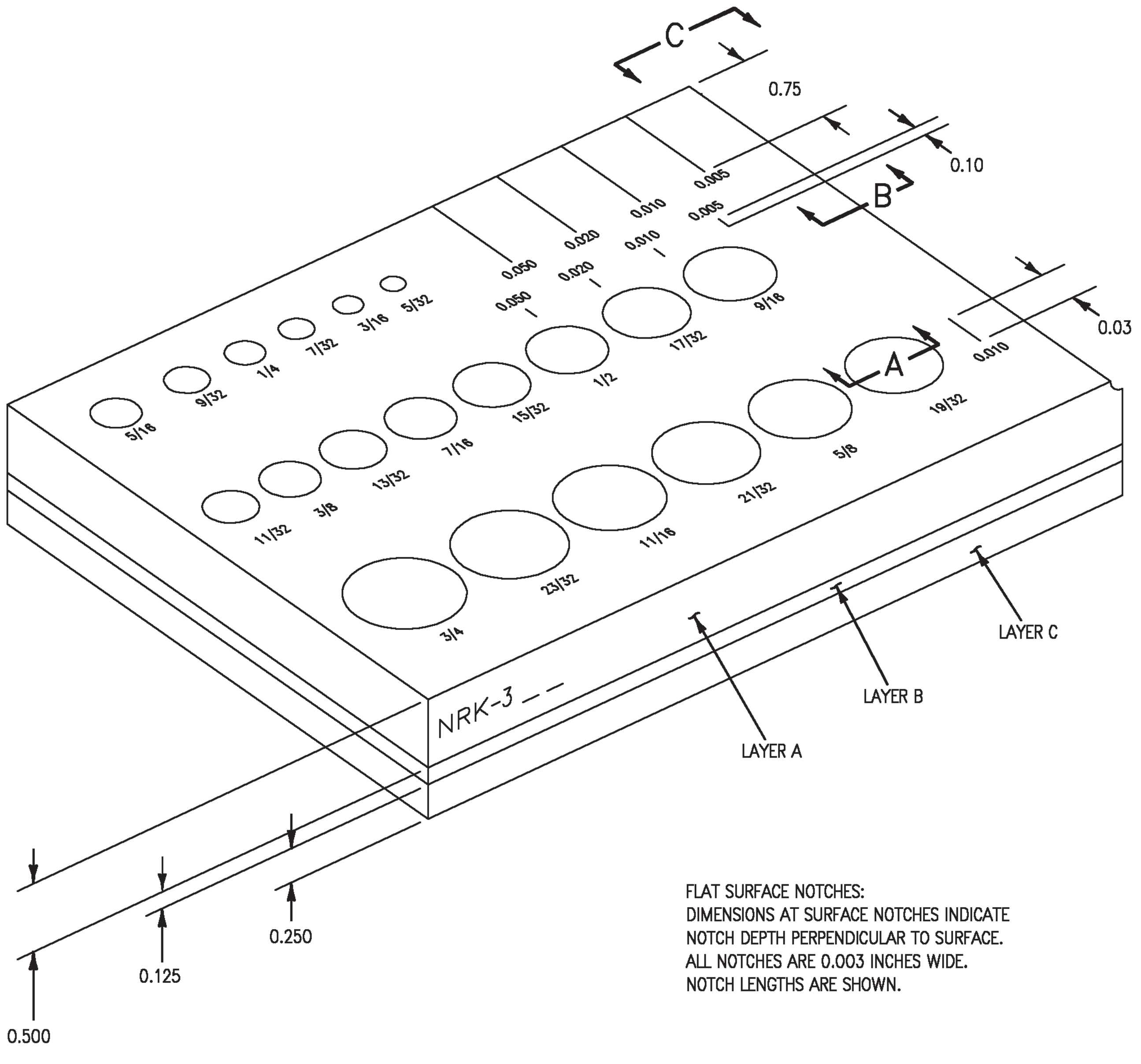
a. If no cracks are found, record inspection was completed in aircraft log book.

b. If cracks are found, map location and dimensions on sketch of part. Include following information; aircraft bureau number, total flight hours, airframe bulletin number, date of inspection and printed or typed name of inspector.



18AC-SRM-30-(381-1)34-CATI

Figure 1. NDT-25N Eddyscope



NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-3AL ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

MAJOR CHANGE

18AC-SRM-30-(382-1)36-CATI

Figure 2. Eddy Current Reference Standard (Sheet 1)

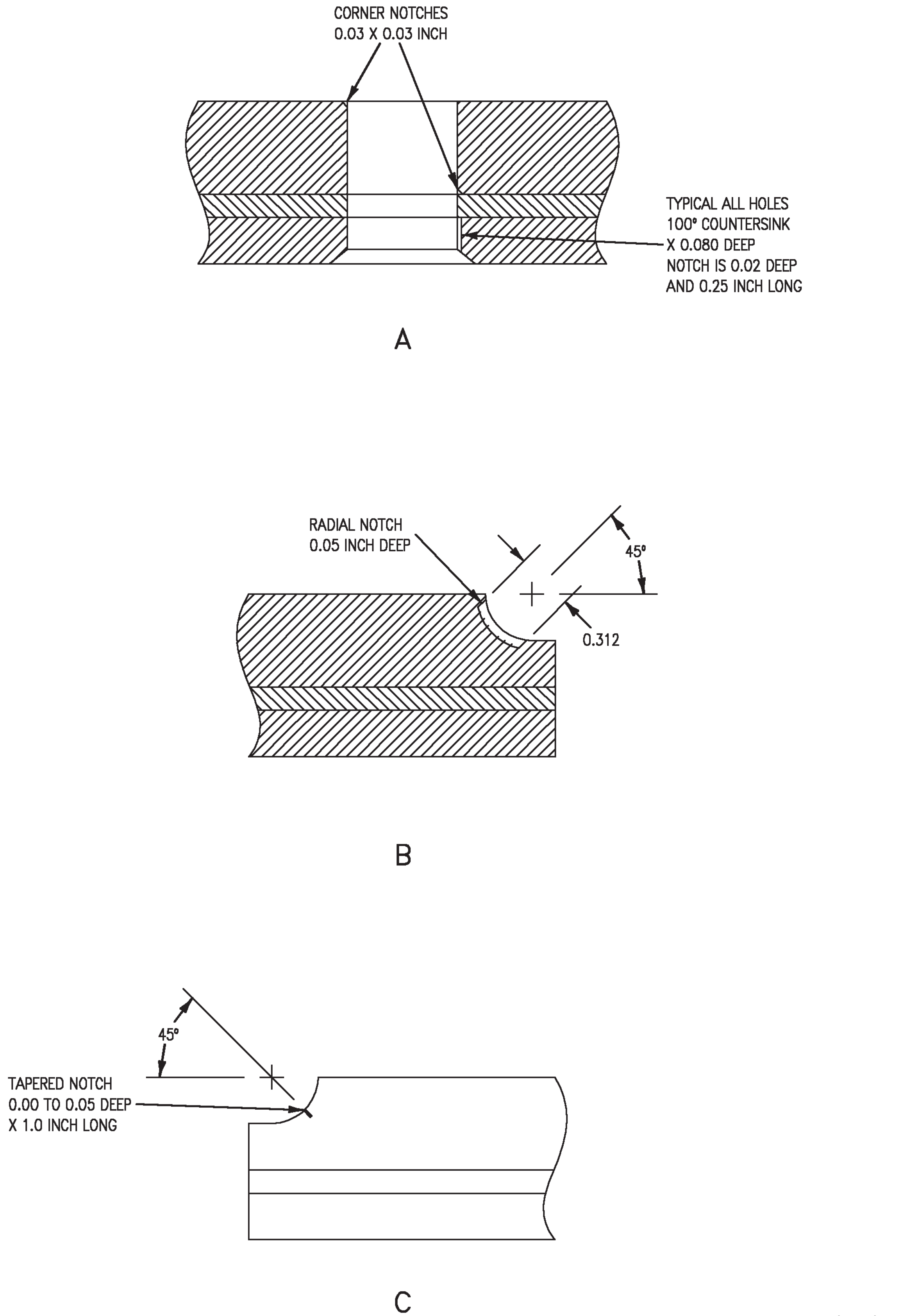


Figure 2. Eddy Current Reference Standard (Sheet 2)

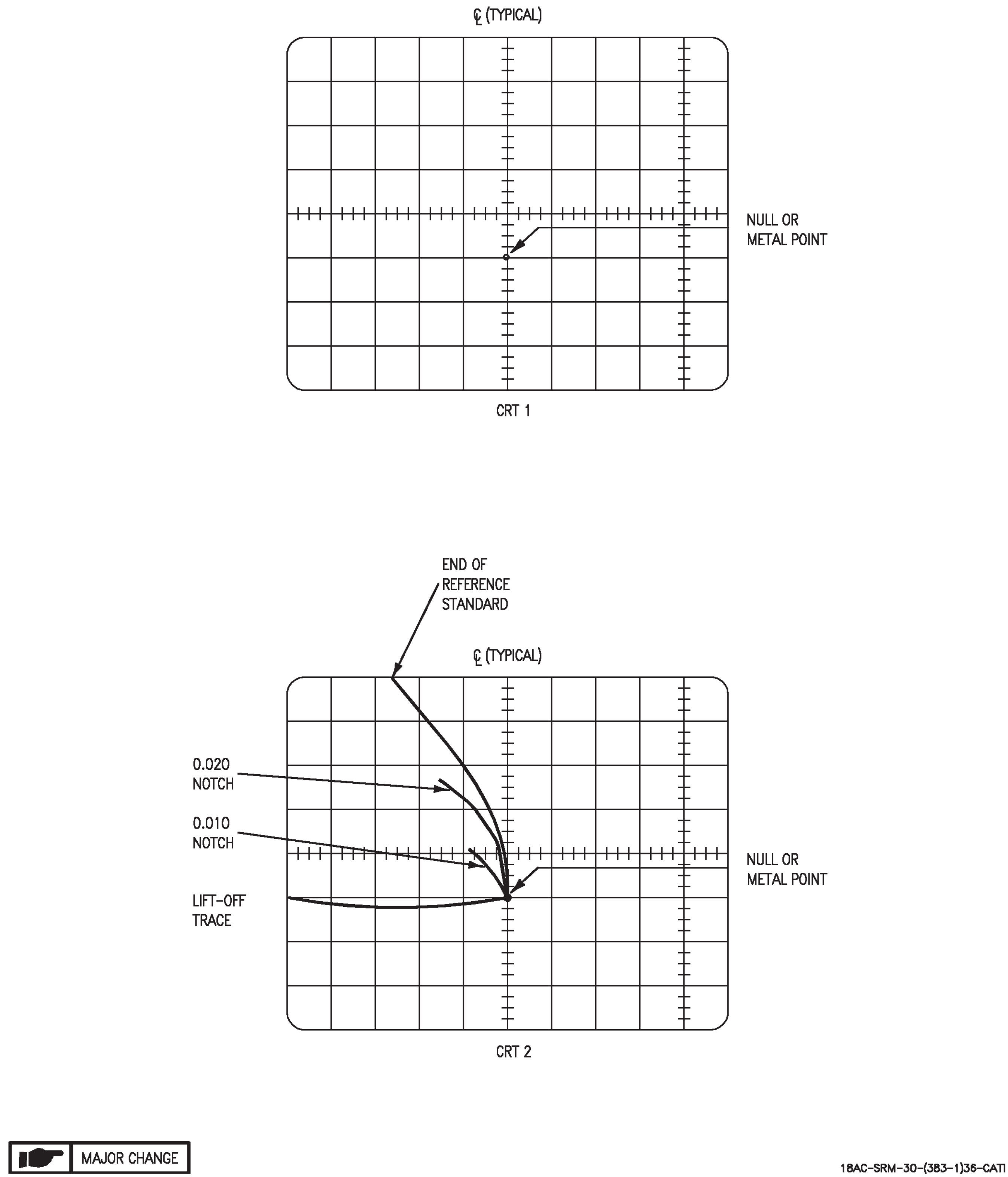


Figure 3. Eddyscope Standardization (Sheet 1)

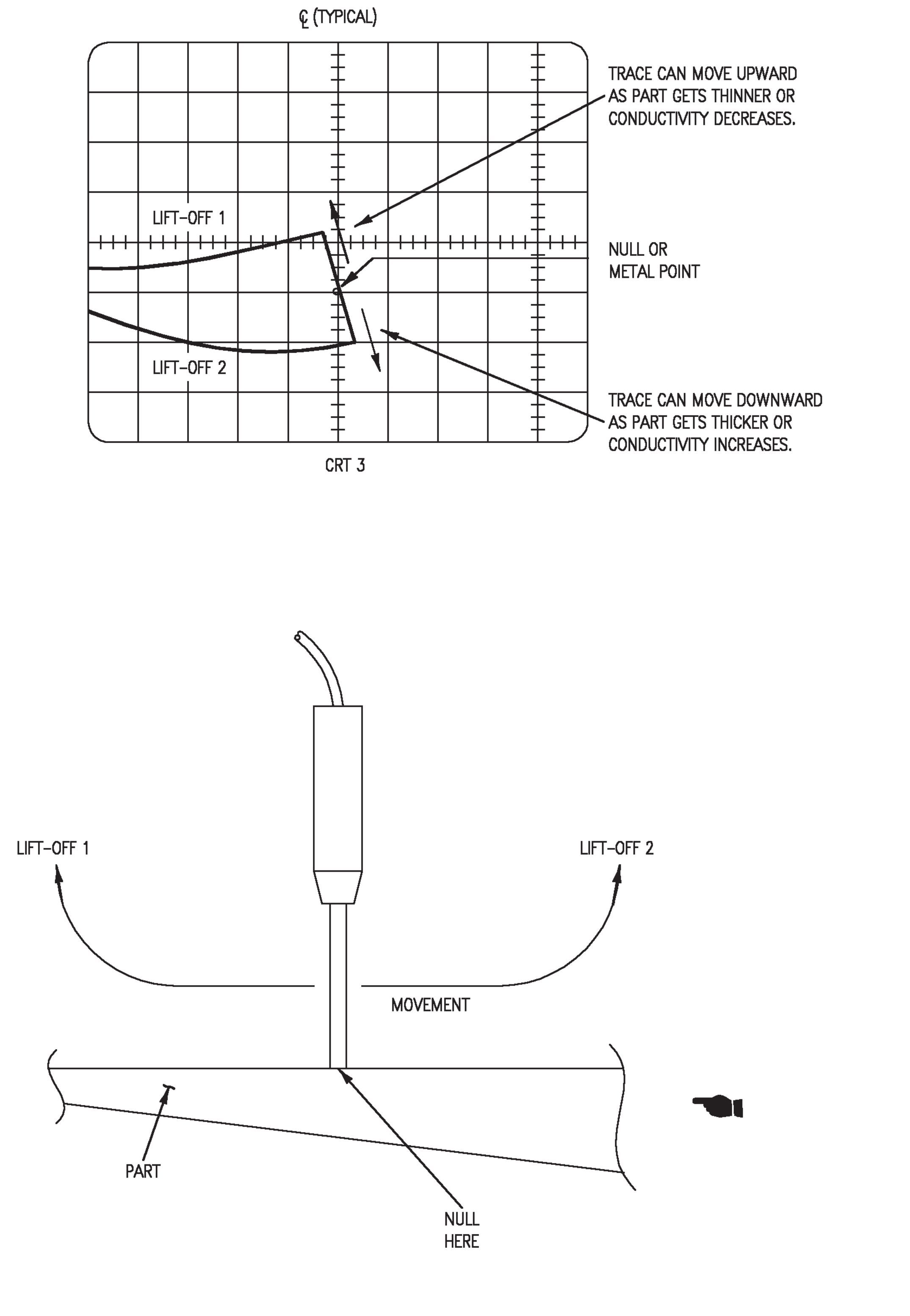
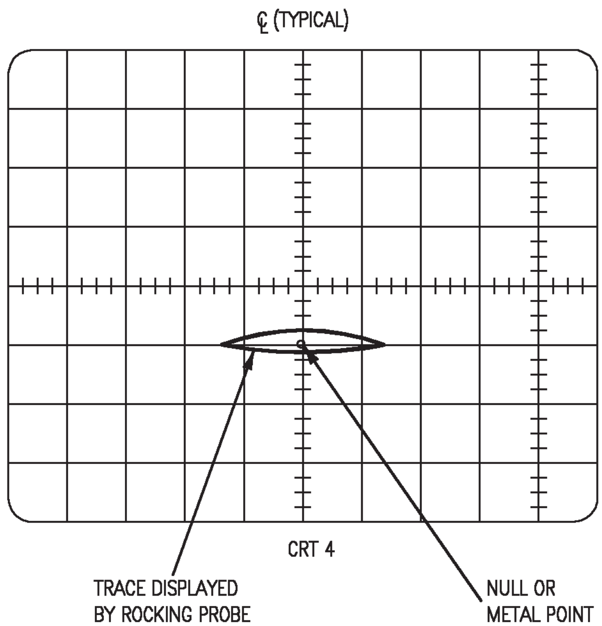


Figure 3. Eddyscope standardization (Sheet 2)



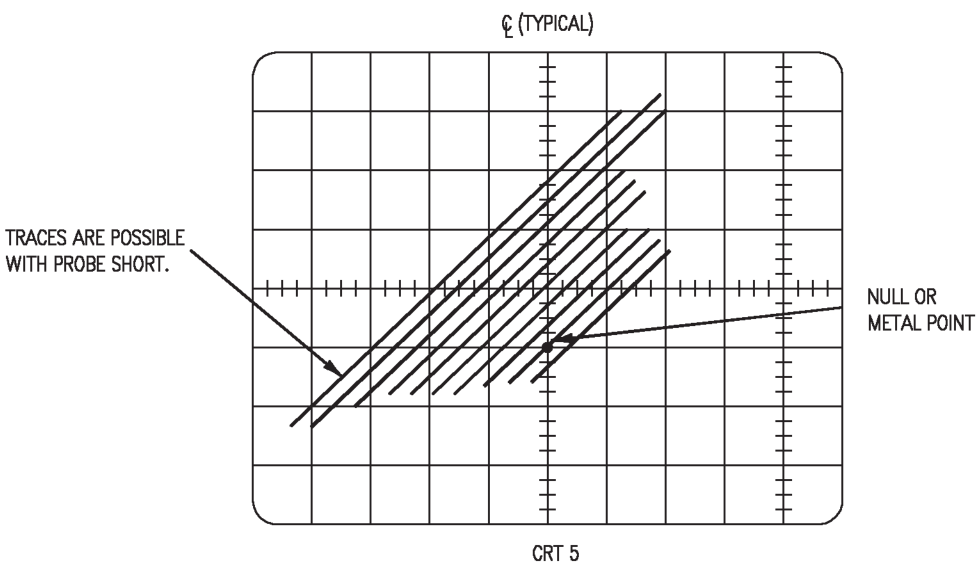


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Figure 3. Eddyscope standardization (Sheet 3)

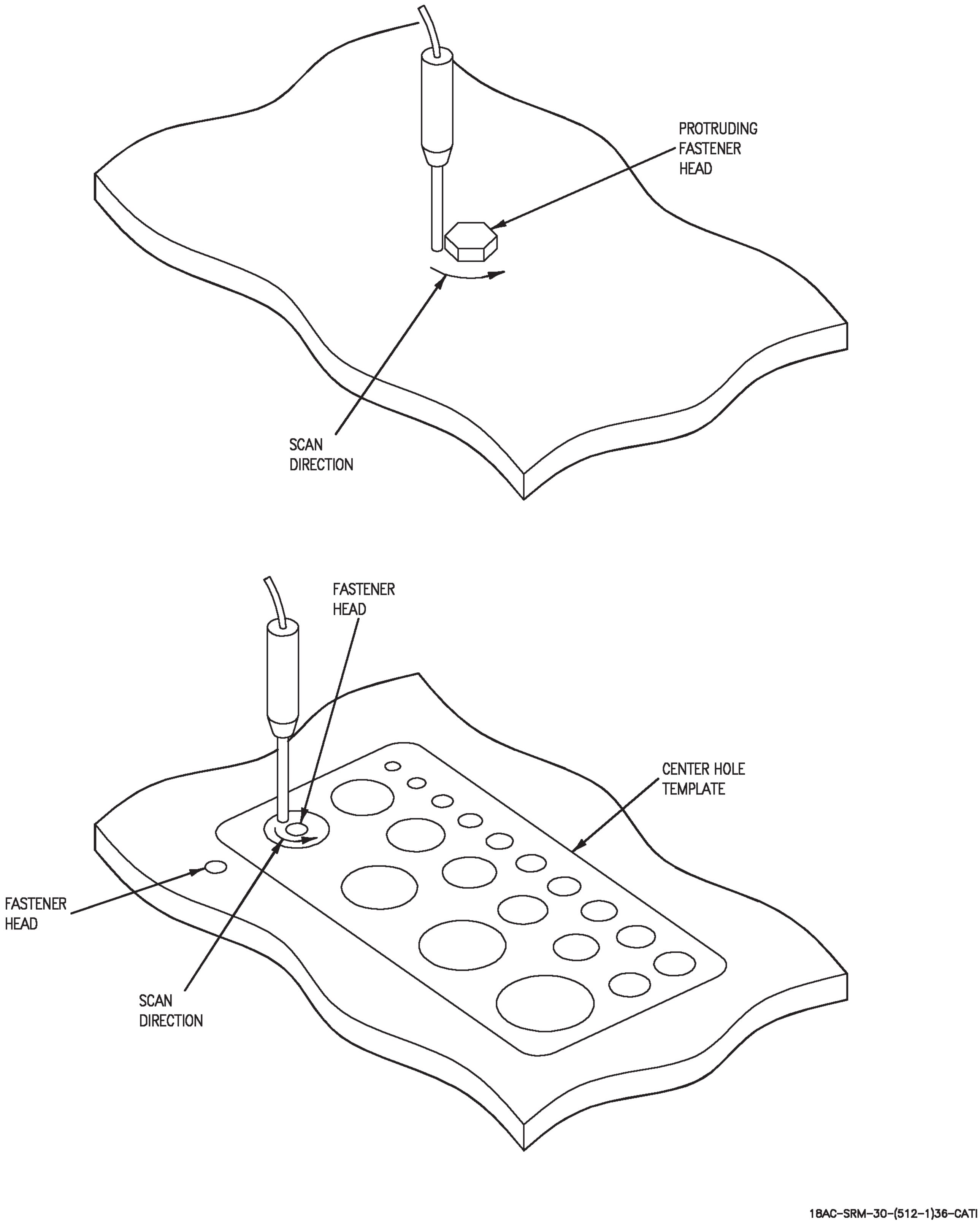
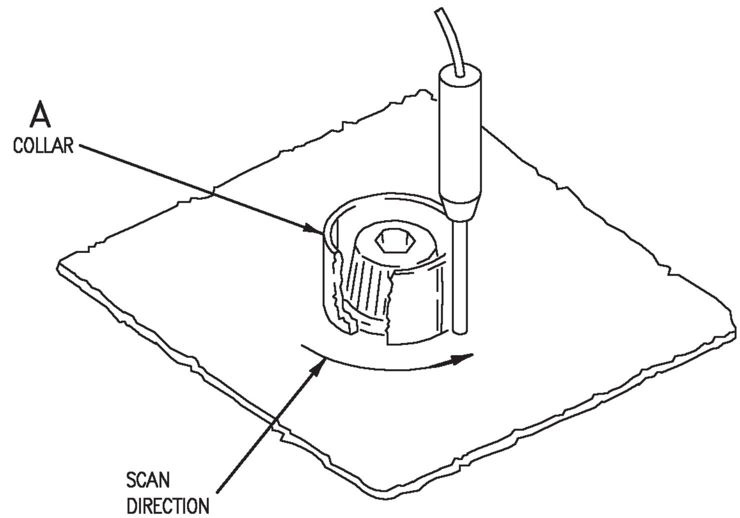
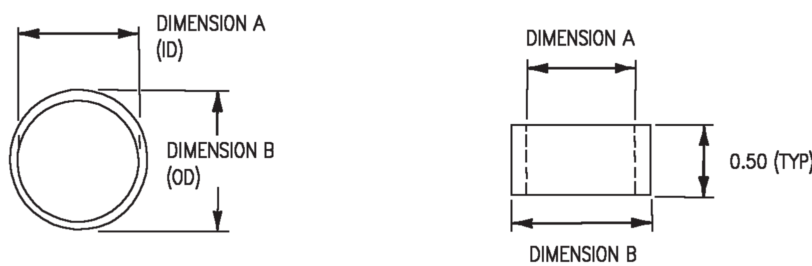


Figure 4. Scanning Near Fasteners





A

FABRICATE FROM PLASTIC (MIL-P-21105),
PHENOLIC, OR OTHER NON-CONDUCTIVE MATERIAL

LEGEND

ID=INSIDE DIMENSION

OD=OUTSIDE DIMENSION

PROBE GUIDE DIMENSIONS	
DIMENSION A (ID) INCHES	DIMENSION B (OD) INCHES
0.250	0.40
0.3125	0.46
0.375	0.52
0.4375	0.58
0.500	0.65
0.5625	0.71
0.6250	0.77
0.6875	0.83
0.750	0.90

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Figure 5. Probe Guide

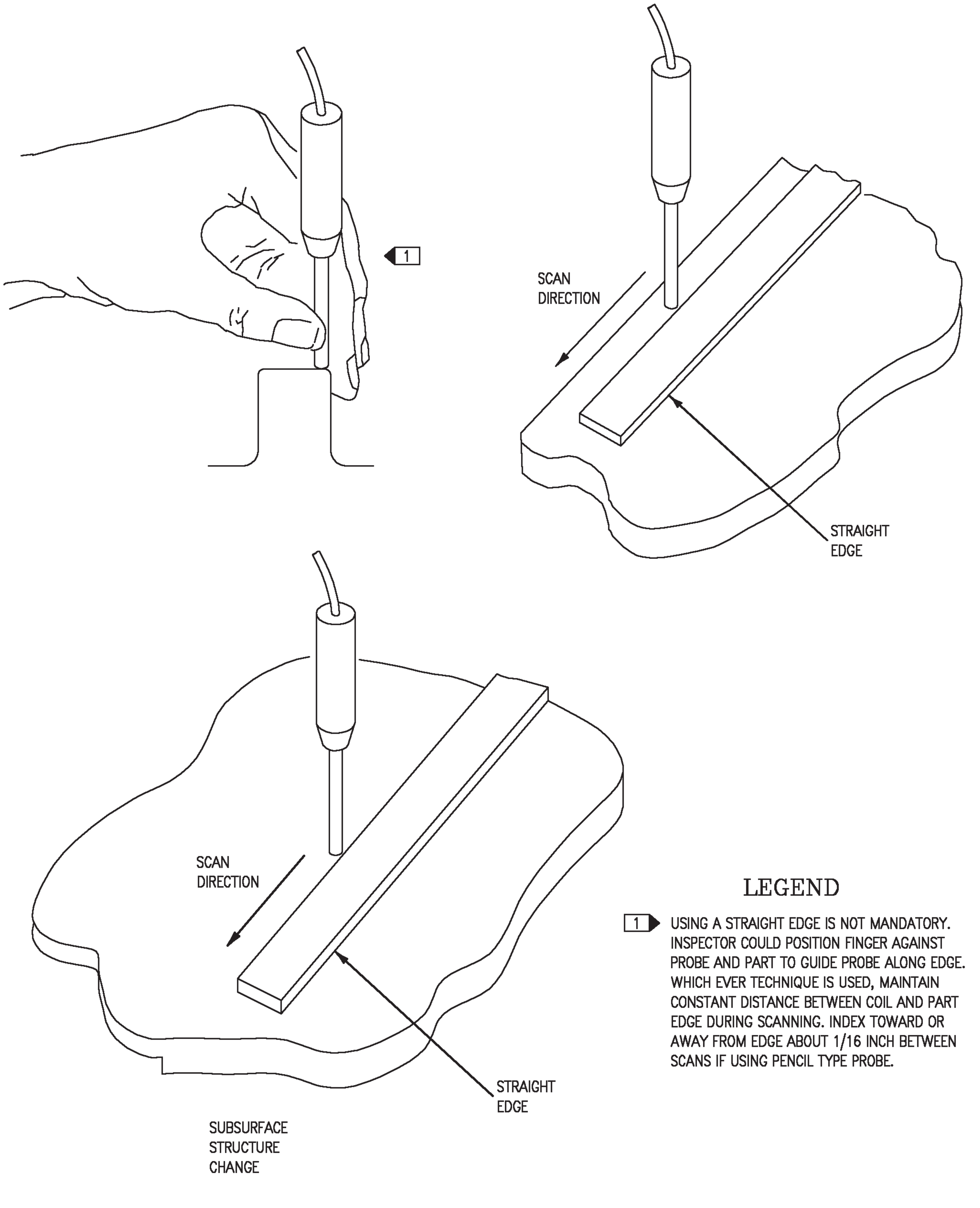
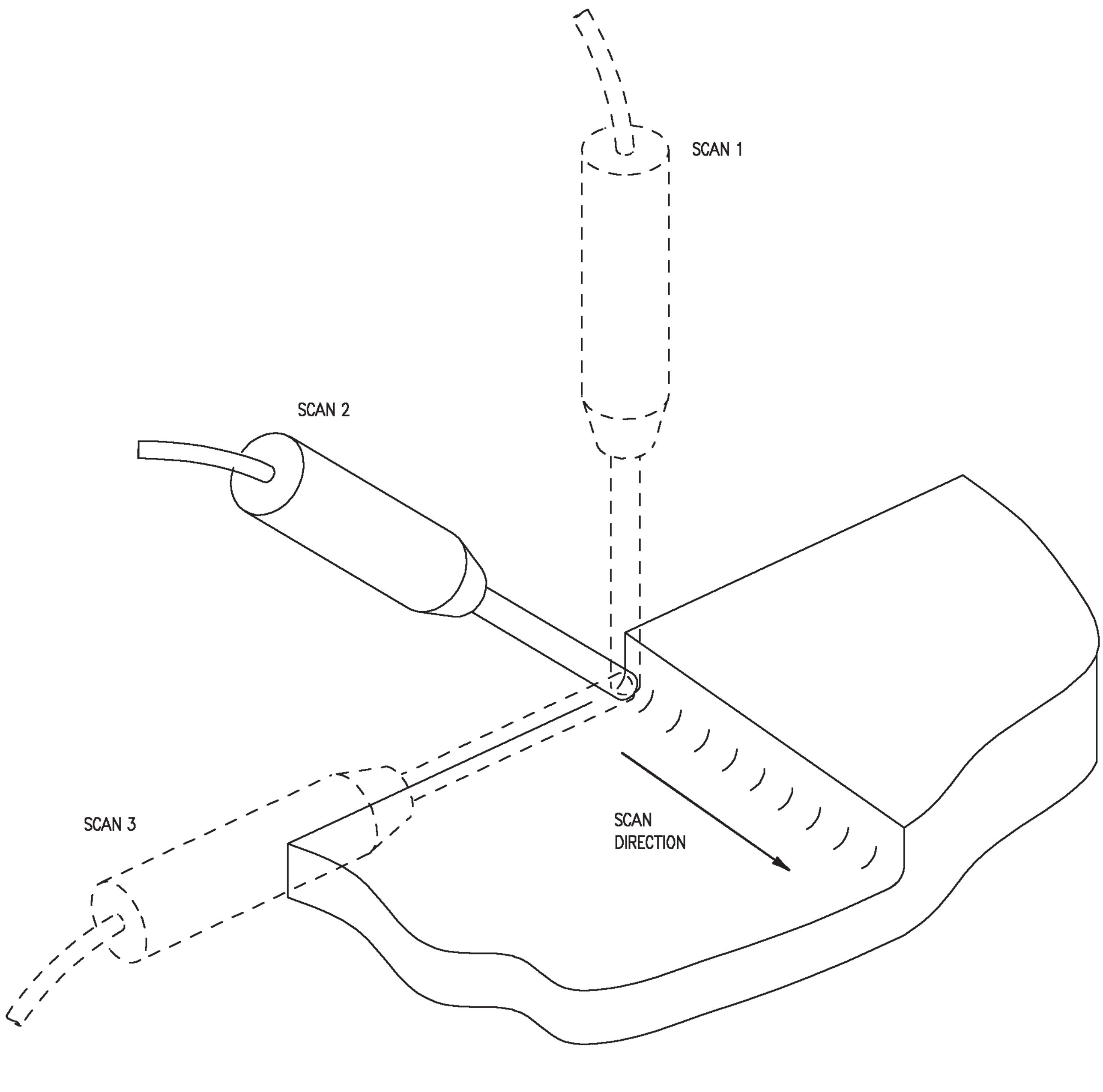


Figure 6. Scanning Along Thickness Changes and Edges of Structure



18AC-SRM-30-(515-1)36-CATI

Figure 7. Scanning Radii

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

HEAT DAMAGE AND OVERTEMPERATURE INSPECTION OF METALS

Reference Material

Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection	A1-F18AC-SRM-300
Magnetic Particle Inspection	WP006 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. This work package defines procedures for doing heat damage and overtemperature inspections on aluminum, cadmium plated steel, stainless steel and other steels, and titanium.

Support Equipment Required

None

Materials Required

Specification or Part Number	Nomenclature
AA1048TY1CL1GRIT 400X9X11 or AA1048TY1CL1GRIT 320X9X11	Aluminum Oxide Abrasive Cloth

3. **HEAT DAMAGE INSPECTION.** Heat damage is often suspected when painted surfaces are

discolored, scorched, or blistered. Heat damage may also occur with only slight changes in color on some aluminum alloys. Amount of color change in paint should not be used to determine amount of damage caused by heat. However, color is useful when identifying amount of damaged areas along with hardness and conductivity testing. Caution must be observed when viewing paint colors for suspect heat damage. Contaminates such as hydraulic fluid, oil, and dirt may cause superficial discoloration of paint. To distinguish between surface contamination of paint and heat damage, sand surface. Paint damage by heat is consistently discolored through thickness of paint and will not change back to original color by sanding. Paint discoloration caused by contaminates is superficial and will usually sand off. There are four primary catagories of material, they are:

a. Aluminum: most affected of materials by heat exposure. Mechanical properties of aluminum may be affected with or without paint discoloring. If heat damage is suspected:

(1) Do conductivity test per paragraphs 4 through 8.

(2) Do hardness test per paragraphs 9 through 13.

b. Cadmium plated steels: more heat resistant than aluminum. Paint will appear discolored, scorched, or blistered before damage occurs. When cadmium plated steels are suspected to have been heated over 610°F:

(1) Do magnetic particle inspection (WP006 00).

(2) Do hardness test per paragraphs 9 through 13.

CAUTION

Rapid heating of stressed cadmium plated steels to temperatures above 610°F, melting paint of cadmium, may cause cracking in the steel.

c. Stainless steels and other steels: virtually unaffected by heat exposure unless long term. If plating is damaged, depot engineering disposition is required. If heat damage is suspected paint will be extensively damaged, do hardness test per paragraphs 9 through 13.

NOTE

Alpha case is hard brittle layer of surface oxidation. This condition will appear as dull non-reflective layer oxide. Bright colors ranging from yellow through red to dark blue are thinner layers of oxide than alpha case and are acceptable.

d. Titanium: effect by heat is negligible. Observe titanium for alpha case condition. If dull non-reflective alpha case condition is suspected engineering disposition is required.

4. **CONDUCTIVITY TEST.** Conductivity testing, represented as percent IACS, is used to evaluate large areas of damage. Conductivity test results will identify areas that may require more detailed inspection. Conductivity instruments may be used as comparators for evaluating aircraft parts or components for variations in tensile properties affected by heat. Typically, conductivity of aluminum increases as temperature exposure of aluminum increases. When aluminum is tested for conductivity, hardness test must also be done.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
FM140A	Digital Conductivity Meter, Magnaflux Corp. or Equivalent
213922	Conductivity Reference Standard
213923	Conductivity Reference Standard

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ke tone
MIL-C-87962, TYPE 1	Cleaning Cloth
—	Thickness Gage
MIL-P-83953-2 TYPE 1, CLASS B, BLACK or RED	Aircraft Marking Pencil

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

5. **Surface Preparation.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material. Paint removal not required if lift-off compensation is made.

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using conductivity meter near aircraft fuel cells, oxygen systems, and stores (A1-F18AC-PCM-000).

NOTE

This setup is for FM140A digital conductivity meter only. Use of other conductivity meters may require different instrument settings.

6. **Digital Conductivity Meter Setup.** Reference standards and probe must always be kept clean. Dirt on samples or particles embedded into probe face can result in incorrect seating of probe on reference standard causing measurement errors. Two or more reference standards are needed for setup of instrument. Reference standards should be identified with engraved percent IACS on back or side. Reference standards should have minimum hi-to-low spread of 10% IACS. Range of conductivity of material to be tested, see table 1, should be in range of conductivity of reference standards. If material is not in range of conductivity of reference standards, alternate standards must be used.

a. Connect digital conductivity meter (instrument) to power supply or use batteries.

b. Turn instrument ON, allow 3 minutes warmup. If batteries are used, observe correct charge. Instrument pointer of battery indicator, BATT, should not be at or near red zone. Recharge batteries if required.

c. Connect probe to instrument.

d. Position probe in center of reference standard with higher percent IACS. Adjust LIFT-OFF to get same reading on display as identified on higher percent IACS reference standard.

e. Put sheet of paper 0.002 to 0.004 inch thick, measured with mechanical thickness gage, between probe and higher percent IACS reference standard; observe reading on display.

f. Remove paper from between probe and reference standard. Observe direction of display reading change.

(1) For downward reading change as probe is positioned on bare reference standard, adjust LIFT-OFF counterclockwise.

(2) For upward reading change as probe is positioned on bare reference standard, adjust LIFT-OFF clockwise.

g. Repeat steps e. and f. until same display reading is observed with or without paper between probe and reference standard. Instrument is now adjusted for 0.003 inch lift-off compensation.

h. With probe still positioned in center of higher percent IACS reference standard, adjust

HIGH to get same display reading as percent IACS values identified on reference standard.

i. Position probe in center of lower percent IACS reference standard. Adjust LOW to get same display reading as percent IACS identified on reference standard.

j. Repeat steps h. and i. until display reading is same as percent IACS values identified on reference standards without adjusting controls.

NOTE

Instrument should be standardized at frequent intervals during inspection. Temperature variations will change instrument readings. Standardization should always be verified when ambient temperature changes occur.

7. **Limitations.**

a. Area(s) to be inspected should be limited to surfaces with finish smoothness of 125 RHR or greater.

b. A thin nonconductive layer of oxide, paint, or scale 0.005 inch thick or less is allowed if instrument is equipped for lift-off compensation or if lift-off correction factors are used.

c. Surface(s) should be flat. However, concave surfaces with radius of curvature over 20 inches and convex surfaces with radius of curvature 2 inches or more can be inspected.

d. Conductivity readings should be taken on metal with thickness at least three eddy current depths of penetration, see figure 1.

e. Cladding has distinct effect on conductivity readings when compared to base metal values. Conductivity readings can be taken, but correct metal type and percent IACS must be used. Alclad parts or components should be between 0.050 and 0.080 inches thick.

8. **Conductivity Test Inspection Procedures.**

NOTE

Temperature of reference standards and metal to be inspected shall be maintained within ±5°F of each other.

a. Standardize instrument on reference standards before measurements are taken. Verify standardization every 30 minutes during continuous operation.

b. If verification of standardization indicates instrument is out of standardization, all measurements made after last satisfactory standardization should be repeated.

NOTE

Because of aluminum characteristics, both hardness test and conductivity test must be done to evaluate heat damage.

c. Position probe firmly on part. Observe display readings and compare values with applicable percent IACS values in table 1. Mark area(s) of part with aircraft marking pencil that do not fall within conductivity range listed in table 1.

Table 1. Hardness and Conductivity for Selected Aluminum Alloys and Tempers

Product Form	Alloy-Temper	Percent IACS	Hardness-Rockwell 2	Minimum Material Thickness (Inches)
Sheet, Clad	2024-T72 2024-T81 7075-T6X 7075-T76	39.0 - 45.0 37.0 - 41.0 30.5 - 36.0 36.0 - 40.0	B56.0 - 76.0 B64.0 Min B76.0 - 90.0 B74.0 - 88.0	0.071 0.056 0.047 0.049

Table 1. Hardness and Conductivity for Selected Aluminum Alloys and Tempers (Continued)

Product Form	Alloy-Temper	Percent IACS	Hardness-Rockwell [2]	Minimum Material Thickness (Inches)
Sheet, Bare	2024-T72	38.0 - 45.0	B64.0 - 76.0	0.056
	2024-T81	36.0 - 41.0	B74.5 Min	0.049
		41.1 - 42.5 [1]	B74.5 Min	0.049
	6061-T4X	35.0 - 41.0	E60.0 Min [3]	0.063
	6061-T6X	40.0 - 45.0	B47.0 - 72.0	0.090
	7075-T6X	30.5 - 34.5	B87.0 Min	0.036
	7075-T76	36.0 - 40.0	B82.0 - 88.0	0.040
Plate	2024/2124-T851	36.0 - 41.0	B74.5 Min	0.049
		41.1 - 42.5 [1]	B74.5 Min	0.049
	7050-T736X	38.0 - 39.9	B82.0 - 88.0	0.040
	(T74X)	40.0 - 41.5 [1]	B82.0 Min	0.040
	7075-T73, T735X	38.0 - 41.0	B78.0 - 84.0	0.045
		41.1 - 43.0 [1]	B78.0 Min	0.045
Hand and Die Forgings	6061-T6, T65X	40.0 - 45.0	B47.0 - 72.0	0.090
	7049/7149-T73	38.0 - 41.0	B81.5 - 85.0	0.040
	or -T735X	41.1 - 43.0 [1]	B81.5 Min	0.040
	7050-T736, T7365X	38.0 - 39.9	B82.0 - 88.0	0.040
	(T74, T745X)	40.0 - 41.5 [1]	B82.0 Min	0.040
	7075-T73, T735X	38.0 - 41.0	B78.0 - 84.0	0.045
		41.1 - 43.0 [1]	B78.0 Min	0.045
	7075/7175-T736	38.0 - 41.5	B82.0 - 88.0	0.040
	(T74)	41.6 - 43.0 [1]	B82.0 Min	0.040
	7075/7175-T73652	38.0 - 41.5	B80.0 - 88.0	0.038
	(T7452)	41.6 - 43.0 [1]	B80.0 Min	0.038

Table 1. Hardness and Conductivity for Selected Aluminum Alloys and Tempers (Continued)

Product Form	Alloy-Temper	Percent IACS	Hardness-Rockwell 2	Minimum Material Thickness (Inches)
Extrusion and Bar Stock	2024-T62	38.0 - 44.0	B72.0 - 83.0	0.050
	2024-T851X	36.0 - 41.0	B74.5 Min	0.049
		41.1 - 42.5	B74.5 Min	0.049
	6061-T6, T651X	40.0 - 45.0	B47.0 - 72.0	0.090
	7049-T73	40.0 - 41.0	B81.5 - 85.0	0.040
	or -T7351X	41.1 - 43.0 1	B81.5 Min	0.040
	7149-T73	40.0 - 41.0	B81.5 - 85.0	0.040
	or -T7351X	41.1 - 43.0 1	B81.5 Min	0.040
	7075-T73, T735X	38.0 - 41.0	B78.0 - 84.0	0.045
		41.1 - 43.0 1	B82.0 - 88.0	
	7075-T76, T765X	36.0 - 40.0		0.040
Castings	A356	N/A	E84.0 - 94.0 3	—

Notes:

1 Metal in this conductivity range shall be 100 percent hardness tested and accepted if hardness requirement is met.
2 Use 1/16-inch Ball penetrator and B scale (100 Kg).
3 Use 1/8-inch Ball penetrator on HRE Readings.

9. **HARDNESS TEST.** Hardness is related to strength of metal. Temperature to which part or component is exposed is also related to strength of metal. Therefore, hardness testing can be used to determine if part or component damage has resulted from its exposure to fire or heat. Surface preparation, limitations, standardization, and hardness testing procedures are provided.

Support Equipment Required

NOTE

Alternate type designations or part numbers listed in parentheses.

Part Number or Type Designation	Nomenclature
M-51 (PHT-1) (M-194100)	Material Hardness Tester, Portable, or Equivalent
4JR	Material Hardness Tester, Stationary, or Equivalent
34525 (94501)	Diamond Penetrator, Brale (1/16-Inch Ball Penetrator)
94502	1/8-Inch Ball Penetrator

Support Equipment Required (Continued)

NOTE

Alternate type designations or part numbers listed in parentheses.

Part Number or Type Designation	Nomenclature
990240	Test Block, B Scale, RB40, Page Wilson Corp.
990280	Test Block, B Scale, RB80 Page Wilson Corp.
990325	Test Block, C Scale, RC25 Page Wilson Corp.
990355	Test Block, C Scale, RC55 Page Wilson Corp.
990557	Test Block, E Scale, RE57 Page Wilson Corp.
990587	Test Block, E Scale, RE87 Page Wilson Corp.

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil

Materials Required (Continued)

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
AA1048TY1CL1GRIT 80X9X11	Aluminum Oxide Abrasive Cloth
AA1048TY1CL1GRIT 240X9X11	
AA1048TY1CL1GRIT 320X9X11	
AA1048TY1CL1GRIT 400X9X11	
AA1048TY1CL1GRIT 600X9X11	

10. **Surface Preparation.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Have paint and primer chemically removed from area(s) to be tested (A1-F18AC-SRM-500, WP007 00).

c. Have ion vapor deposition (IVD) coating mechanically removed from area(s) to be tested using 400 grit aluminum oxide abrasive cloth.

d. Have correct surface finish, smoothness, prepared using aluminum oxide abrasive cloth, refer to paragraph 11.

11. **Limitations.**

a. Surface finish of 250 RHR or better is required to do hardness testing with M-51 hardness tester.

b. Superficial hardness test should only be done on surfaces with finishes of 63 RHR or finer.

c. Ultrasonic hardness test should only be done on surfaces with finish of 32 RHR or finer.

NOTE

Accuracy of hardness test may be seriously affected by penetrator alignment/incorrect tester clamp up.

d. Hardness measurements should not be done when any of following conditions exist:

(1) Through paint, primer, and IVD; these cause low readings.

(2) On convex surfaces with radius curvature less than 1 inch.

(3) Within 2 impression diagonals or diameters from edge of another impression.

(4) Closer than 0.1 inch of edge, hole, radius, or fillet.

12. **Standardization.** See figure 2.

NOTE

Standardize hardness tester before testing, after changing penetrator or supporting anvil, when test load is changed, or when change in hardness range (over 5 units RC or equivalent) is made.

a. Install correct penetrator (detail 2), for metal to be tested. Refer to tables 1 and 2 for correct scale and table 3 for penetrator to match scale.

Table 2. Hardness and Minimum Material Thickness for Selected Alloy Steels

Alloy	Hardness (HRC)	Minimum Material Thickness (Inches)
4130, 4140, 4340	27 - 34	0.060
	34 - 40	0.055
	41 - 45	0.050
HP 9-4-20	41 - 45	0.050
HP 9-4-30	46 - 49	0.045
300M	53 - 55	0.040
AF1410	47 - 50	0.045
PH 13-8Mo (Cres)	43 - 47	0.050
PH 15-5, 17-4 PH (Cres)	35 - 39	0.055
NOTE:		
1. Use C scale, Diamond Ball penetrator (150kg).		

Table 3. Rockwell Hardness Scale Designation for Type of Penetrator

Scale Designation	Penetrator		Dial Figure 2
	Type	Dia. Inches	
B	Ball	1/16	Red, Inner Scale
C	Diamond Cone	1/16	Black, Outer Scale
E	Ball	1/8	Red, Inner Scale

b. Use correct anvil (detail 3), for part being tested. For example, use goose neck anvil when testing thin wall tubing, do not use spot anvil.

c. When changing anvil, (detail 3), remove penetrator (detail 2), or protect it by covering it with your hand or fingers to prevent damage.

d. Inspect penetrator (detail 2), and anvil (detail 3), at regular intervals using 10X magnifier to make sure they are not damaged.

NOTE

Change penetrator/anvil if doubt of damage exists.

e. Select reference test block with correct scale and hardness range, ±5RH of part to be tested, refer to tables 1 and 2.

CAUTION

Failure to rotate load wheel counterclockwise before positioning test block into hardness tester may result in inaccurate readings/damage to hardness tester.

f. Before positioning reference test block into hardness tester, rotate load wheel (detail 5), counterclockwise until penetrator (detail 2), is completely in open position.

g. Position reference test block between clamp jaws (detail 1), and tighten using clamp screw wheel (detail 4).

h. Rotate dial set ring (detail 10), on setup/scale dial (detail 7), to preload dot position (detail 8).

i. Rotate load wheel (detail 5), clockwise until needle on setup/scale dial (detail 7), moves to SET position.

j. Rotate dial set ring, (detail 10), on hardness read dial (detail 11), to BLACK ZERO.

NOTE

Black zero on hardness read dial is used for all initial hardness test setup.

k. Continue to rotate load wheel (detail 5), slowly clockwise until needle on setup/scale dial (detail 7), approaches scale of test block.

NOTE

If correct setting is overrun, release preload and reapply in another location. Scale used on load wheel must be same as test block scale together with correct penetrator.

l. When needle points directly at correct scale on setup/scale dial (detail 7), rotate load wheel (detail 5), slowly counterclockwise until needle points directly at SET on hardness read dial (detail 11).

m. When needle points directly at SET on setup/scale dial (detail 7), observe reading on hardness read dial (detail 11). Be sure to read correct scale increments and color. Example: black outer increments for C scale and red inner increments for B and E scales, refer to table 3.

NOTE

Readings on hardness read dial must be within tolerances of hardness tester and test block, hardness tester shall be recalibrated.

n. Average of at least three readings must be taken on test block.

13. **Hardness Test Procedure.**

a. Determine type material and heat treat condition of part/component to be tested, refer to tables 1 and 2.

NOTE

Paint, plating, and foreign material will cause inaccurate hardness readings if not removed before hardness test.

b. Do standardization per paragraph 12 using test block with same hardness, ±5RH, as metal being tested.

CAUTION

Failure to rotate load wheel counterclockwise before positioning test block into hardness tester may result in inaccurate readings/damage to hardness tester.

c. Before testing part, rotate load wheel (detail 5), counterclockwise until penetrator is completely in upmost position.

NOTE

Make sure part is positioned squarely and firmly in clamp jaws.

d. Position part/component to be tested between clamp jaws (detail 1), and tighten clamp using clamp screw wheel (detail 4).

e. Rotate dial set ring, (detail 10), on setup/scale dial (detail 7), to preload dot position (detail 8).

f. Rotate load wheel (detail 5), clockwise until needle on setup/scale dial (detail 7), moves to SET position.

g. Rotate dial set ring, (detail 10), on hardness read dial (detail 11), to BLACK ZERO.

NOTE

Black zero on hardness read dial is used for all initial hardness test setup.

h. Continue to rotate load wheel (detail 5), slowly clockwise until needle on setup/scale dial (detail 7), approaches scale on test block.

NOTE

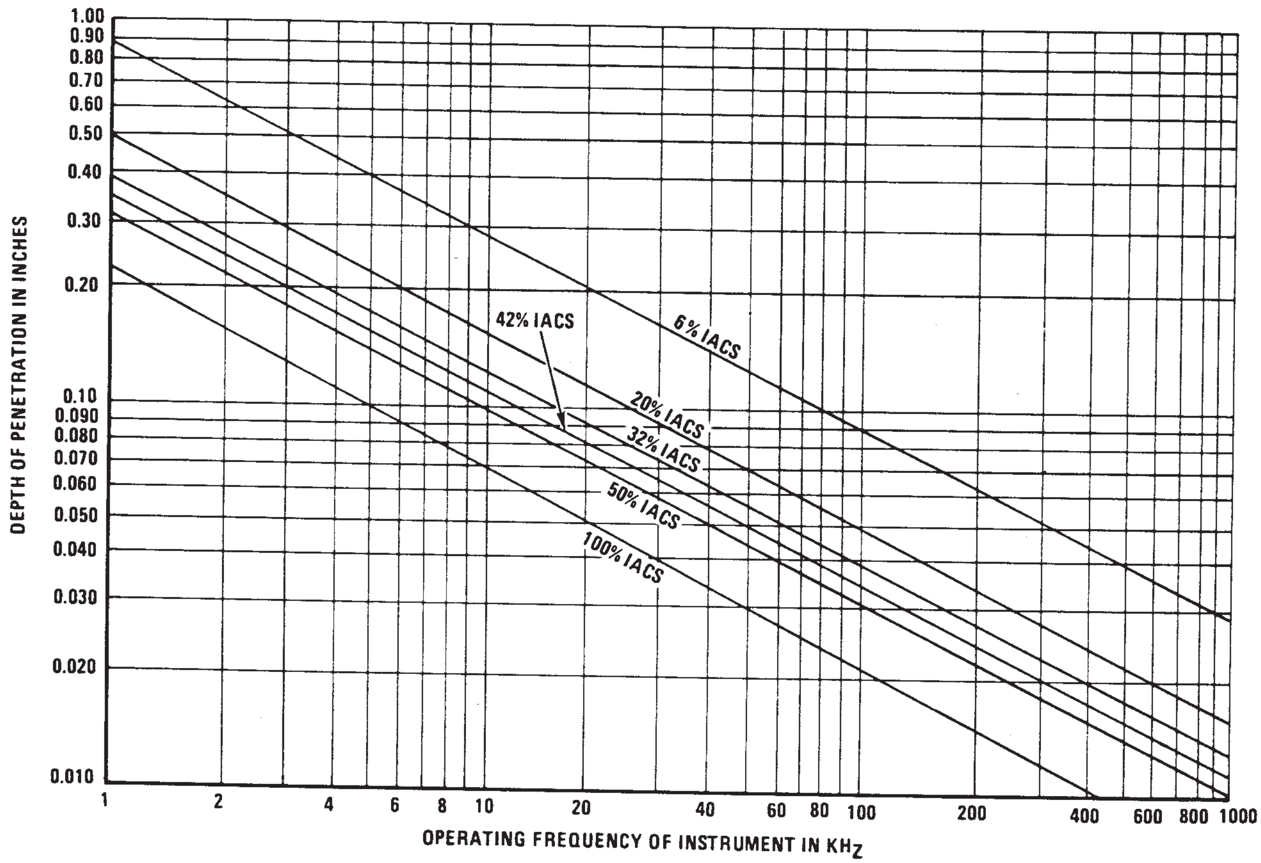
If correct setting is overrun, release preload and reapply in another location.

Scale used on load wheel must be same as test block scale together with correct penetrator.

i. When needle points directly at correct scale on setup/scale dial (detail 7), rotate load wheel (detail 5), slowly counterclockwise until needle points directly at SET on hardness read dial (detail 11).

j. When needle points directly at SET on setup/scale dial (detail 7), observe reading on hardness read dial (detail 11). Be sure to read correct scale increments, color, example; black outer increments for C scale and red inner increments for B and E scales.

k. Repeat steps c through i at least three times every 6 inches and use average of three readings for comparison with tables 1 and 2. Hardness readings out of ranges listed in tables 1 and 2 shall be recorded.

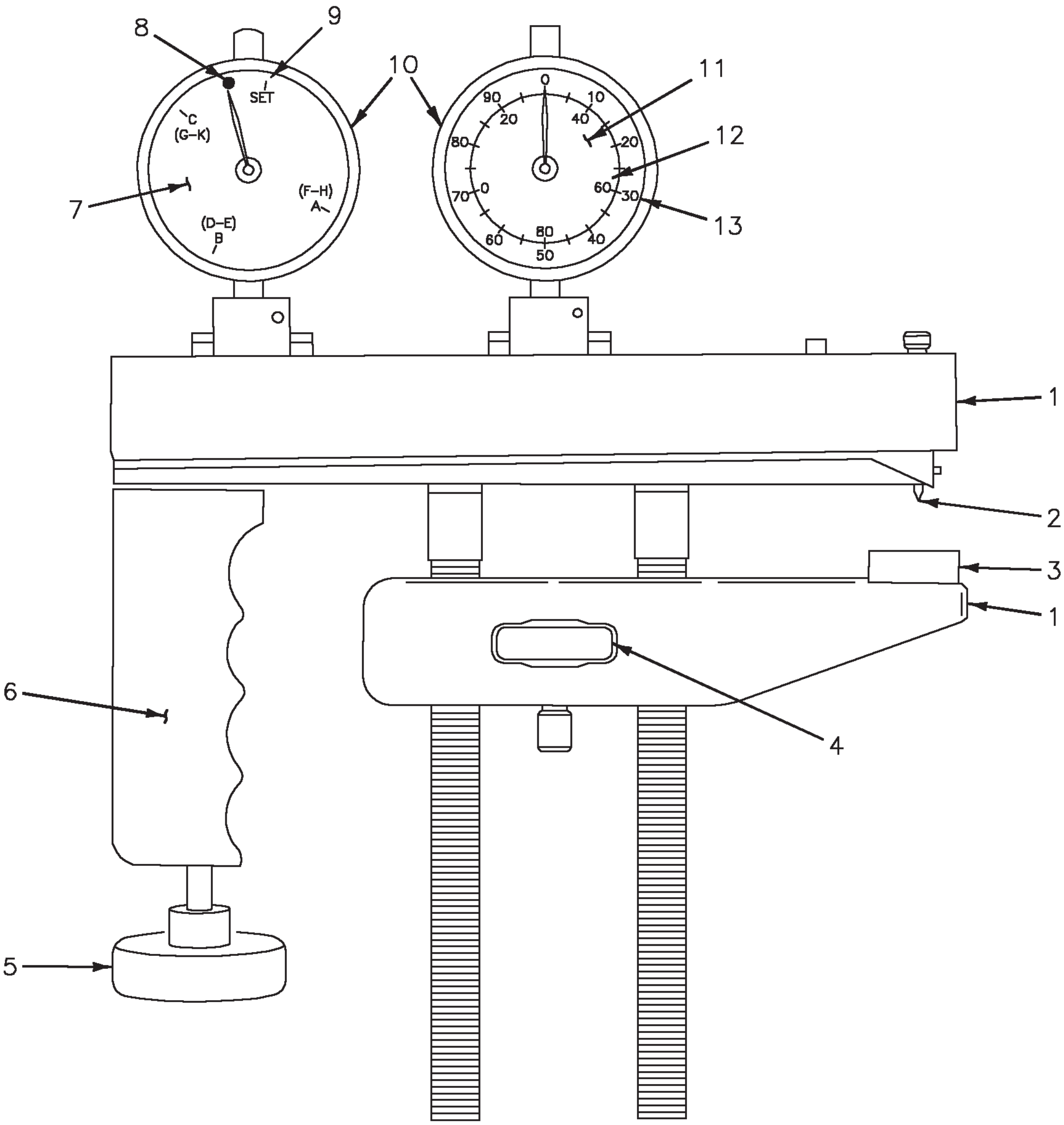


LEGEND

DEPTH OF PENETRATION ON THIS FIGURE IS 2.7 STANDARD DEPTHS OF PENETRATION FOR GIVEN MATERIAL. USE OF THIS GRAPH WILL MAKE SURE THICKNESS DOES NOT AFFECT READOUT.

(U/G)
18AC-SRM-30-(29)21

Figure 1. Eddy Current Depth of Penetration as a Function of Conductivity and Operation Frequency



ITEM	NOMENCLATURE
1	CLAMP JAWS
2	PENETRATOR
3	ANVIL
4	CLAMP SCREW WHEEL
5	LOAD WHEEL
6	PISTOL GRIP
7	SETUP SCALE DIAL
8	PRELOAD DOT POSITION
9	SET POSITION
10	DIAL SET RINGS
11	HARDNESS READ DIAL
12	RED INNER SCALE
13	BLACK OUTER SCALE

18AC-SRM-30-(30-1)21-CATI

Figure 2. Portable Hardness Tester, M-51

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

EDDY CURRENT ABSOLUTE HOLE INSPECTION OF ALUMINUM, TITANIUM, AND STEEL ALLOYS USING NDT-25N IMPEDANCE PLANE EDDYSCOPE

This WP supersedes WP007 05, dated 1 December 1992.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000
Eddy Current Flaw Detector, MXU-713/E	NAVAIR 17-15-82
Operation Instructions, Eddy Current Flaw Detector, MXU-713/E, NDT-25N	WP005 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum, Titanium, and Steel Alloys Using NDT-25N Impedance Plane Eddyscope	WP007 03

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. This work package defines safety requirements, support equipment, surface preparation, materials, standardization, and inspection procedures for hole crack detection in aluminum, titanium, and steel alloys.

3. **SAFETY REQUIREMENTS.** Make sure safety requirements have been met before using electrical equipment near aircraft fuel cells, oxygen systems, and stores (A1-F18AC-PCM-000).

4. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/ MOS 6044.

NOTE

Reference standard is considered equivalent if it is same base material as part to be inspected and contains at least two electrical discharge machined (EDM) surface notches 0.030 X 0.030 deep through thickness of hole or at corner.

This procedure is intended to be used with many different absolute probe types/manufacturers. However, when possible, use probe from the GPK-36 / F/A-18 Navy probe kit. Any absolute surface probe may be used if frequency meets those listed below and probe fits adapter. Specific procedure work package should specify probe selection.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N, MXU-713/E	Programmable Eddy scope, Nortec
9505955	NDT-25N Accessory Kit; List of Contents (NAVAIR 17-15-82, WP004 00)
GPK-36 / F/A-18 or EQUIVALENT	Navy Probe Kit
NRK-3AST or EQUIVALENT	Navy Reference Standard Kit
GPK-36 / F/A-18 or EQUIVALENT	BNC to Microdot Connecting Cable

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
M83953-1 or -2	Pencil, Aircraft Marking
MIL-C-87962, TYPE I	Cleaning Cloth

5. **Equipment Settings/Standardization/Setup.**

a. Attach adapter, if required, which is part of accessory kit, to PROBE connection on Eddyscope, see figure 1.

NOTE

Some probes require use of additional probe for use as reference coil. For these, probe adapter with two ports will be used and required probes are connected to both ports of adapter. One probe is used for inspection and other probe used as reference coil. Reference coil must be kept away from electrically conductive material.

b. Connect probe, see table 1, being used for inspection to test port of adapter.

Table 1. Eddy Current Hole Probes in the GPK-36 / F/A-18 Navy Probe Kit.

Probe P/N	Frequency	Description
BPMF-10/ 300K	150 to 500 kHz	5/32 Inch Dia, F.S., Split shaft, Standard Length
BPMF-12/ 300K	150 to 500 kHz	3/16 Inch Dia, F.S., Split shaft, Standard Length
BPMF-14/ 300K	150 to 500 kHz	7/32 Inch Dia, F.S., Split shaft, Standard Length
BPMF-16/ 300K	150 to 500 kHz	1/4 Inch Dia, F.S., Split shaft, Standard Length
BPMF-18/ 300K	150 to 500 kHz	9/32 Inch Dia, F.S., Split shaft, Standard Length
BPMF-20/ 300K	150 to 500 kHz	5/16 Inch Dia, F.S., Split shaft, Standard Length
BPMF-24/ 300K	150 to 500 kHz	3/8 Inch Dia, F.S., Split shaft, Standard Length
BPMF-28/ 300K	150 to 500 kHz	7/16 Inch Dia, F.S., Split shaft, Standard Length

Table 1. Eddy Current Hole Probes in the GPK-36 / F/A-18 Navy Probe Kit. (Continued)

Probe P/N	Frequency	Description
BPMF-32/ 300K	150 to 500 kHz	1/2 Inch Dia, F.S., Split shaft, Standard Length
BPMF-36/ 300K	150 to 500 kHz	9/16 Inch Dia, F.S., Split shaft, Standard Length
BPMF-40/ 300K	150 to 500 kHz	5/8 Inch Dia, F.S., Split shaft, Standard Length
BPM-8/ 300K	150 to 500 kHz	1/8 Inch Dia, Un-shielded, 3 Inch Length
Notes: 1. F.S. =Ferrite Shielded . 2. Standard length =3 to 3.5 inches.		

c. Connect NULL/ERASE remote, which is part of accessory kit, to computer connection on eddyscope, if desired.

d. If external power is to be used, connect power source to Eddyscope power input.

e. Turn eddyscope ON, press ON button.

f. Status of settings should be as follows; status light on button will indicate whether function is ON or OFF.

H/V .... ON
SP.................................... OFF
I/O SWITCHES............. OFF
HORN .... OFF
NON-STORE .... OFF

g. Set front face settings as noted below; Settings are entered by first pressing button of desired function, current setting will be given on digital display. Current setting may be change by pressing up or down directional buttons, indicated by triangular arrow, or by entering in desired setting value on key pad, and pressing ENTER.

NOTE

Following settings may be adjusted by technician to optimize signal response during standardization.

	Alu-minum	Titanium	Steel
GAIN	36	44	46
FREQ	200 kHz	1000 kHz	20 kHz
FILTER	0	0	0
H SENS	1	1	1
V SENS	0.2	0.2	0.5

NOTE

For definitions of controls and indications on Eddyscope (NAVAIR 17-15-82, WP005 00).

h. Probe used as reference coil shall be kept away from electrically conductive material.

i. Adjust probe collar so center of coil is at depth of EDM notch. Coil and set screw should be in line with each other.

NOTE

Location of EDM notches will vary depending on reference standard. NRK-3AST reference standards have 0.030x0.030 corner notch on top plate and 0.020 through thickness notch on bottom of plate.

j. Position inspection probe in reference standard hole with same nominal hole size as hole to be inspected, see figure 2.

k. Press NULL, see figure 1. Probe coil must be in contact with metal and positioned away from EDM notch.

l. Press POS button and directional buttons until dot is positioned on CRT as shown in figure 3, CRT 1.

NOTE

On succeeding operations press ERASE button, as required.

m. Adjust ANGLE, as required, to receive trace on CRT similar to trace shown on figure 3, CRT 2, as probe coil is pushed from side of hole, lift-off. If enough lift-off can not be received, next larger hole size may be used to establish lift-off response.

n. With probe in correct reference standard hole, rotate coil over EDM notch. Trace should appear on CRT similar to those shown on figure 3, CRT 2. If trace is not similar, adjust GAIN and ANGLE until trace is similar. Press NULL after any change to GAIN.

o. Scan probe over EDM notches on reference standard. Traces should appear on CRT similar to those shown on figure 3, CRT 2. If traces are not similar, adjust GAIN and ANGLE until similar. Press NULL after any change(s) to GAIN.

6. **Preparation of aircraft.** Prepare aircraft as required.

7. **Inspection Procedure.**

a. Visually inspect inspection area. Flashlight and mirror may be required. Cracked area(s) may show accumulation of dirt or soot.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

c. Adjust probe collar so coil center is 1/16-inch below collar.

d. Position probe in hole to be inspected.

e. View lift-off direction. If lift-off direction is not in horizontal direction, similar to figure 3, CRT 2, adjust ANGLE so it is.

f. Press NULL and ERASE.

g. Rotate probe in hole at rate of one revolution per 5 seconds. Monitor CRT for indications with vertical movement, similar to those observed from reference standard, see figure 3, CRT 2.

NOTE

Due to variation in conductivity from part-to-part or from reference standard-to-reference standard, trace direction may rotate slightly. Parts less conductive than reference standard will have traces rotated counter clockwise. Parts more conductive than reference standard will have traces rotated slightly clockwise from those traces shown in figure 3.

h. Press NULL and ERASE, as required, to keep dot position on screen during scanning. Flying dot position may change with conductivity variations, edge effect from edge of hole, and probe rock. It is acceptable for dot on CRT to travel along lift off line as long as it remains within 2 major divisions from side of CRT screen. Rescan any area in which flying dot has left CRT, be careful to maintain perpendicular contact between probe tip and part.

i. After completing revolution, adjust collar to index additional 1/16-inch into hole. Repeat steps e. through j until full depth of hole has been inspected.

j. If coil is shorting against surface of part traces similar to those shown in figure 3, CRT 3 can result, these traces will be in one direction only depending on material being tested. To correct this, add one layer of cellulose tape over coil and restandardize per paragraph 5. Continue to monitor condition of tape and replace when hole forms.

8. **Crack Evaluation.**

a. Determine crack(s) position in hole by scanning back and forth over crack indication. Probe position should be marked on edge of hole where vertical displacement is maximum on CRT.

b. Determine crack length into hole by scanning back and forth over crack indication at different depths. Assume crack termination at centerline of probe when dot returns to normal position on CRT.

c. Report cracks by hole location, crack position around hole, and crack length into hole.

d. If surface around hole is exposed, WP007 03 should be used to determine if crack length away from hole can be determined.

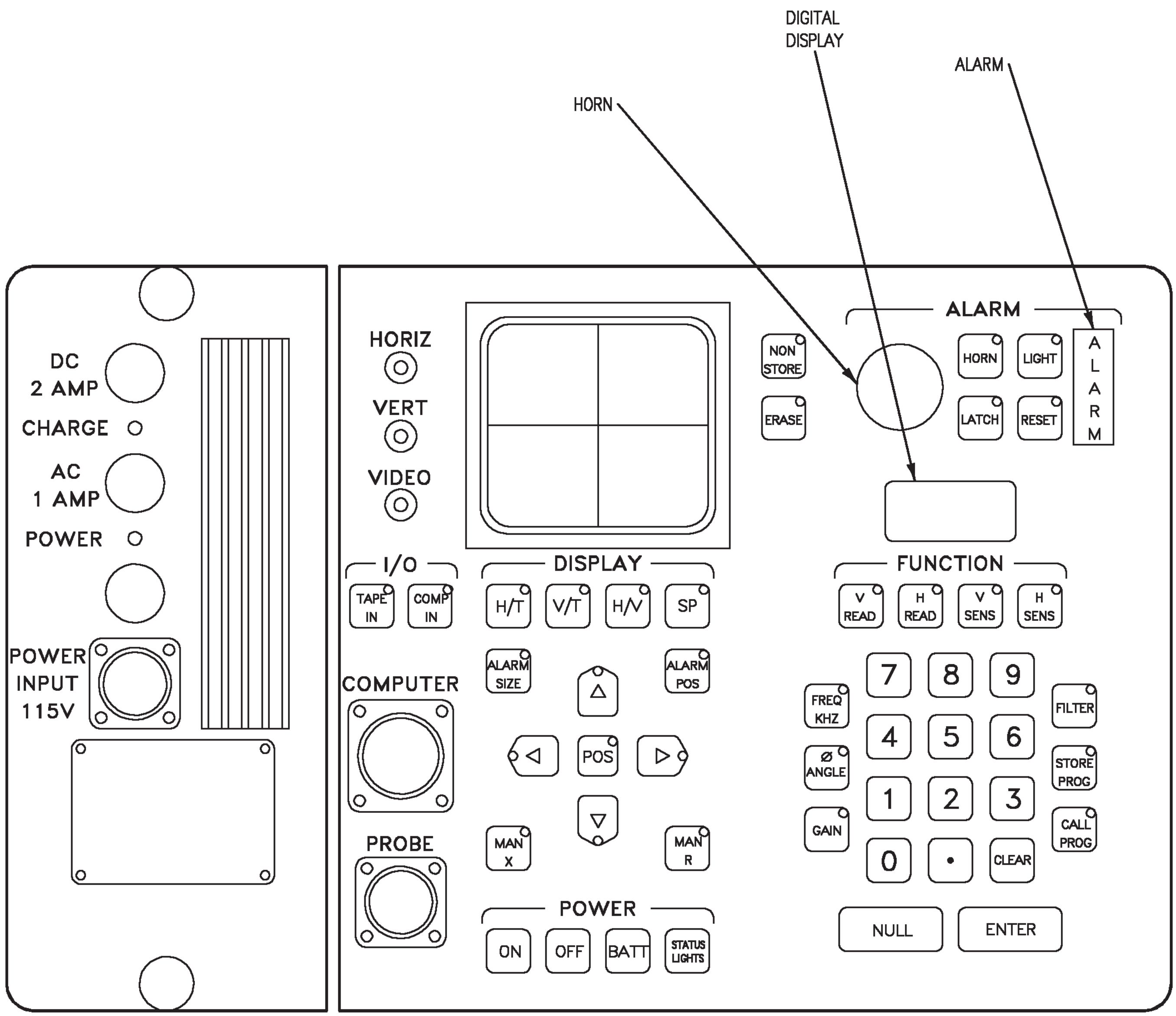
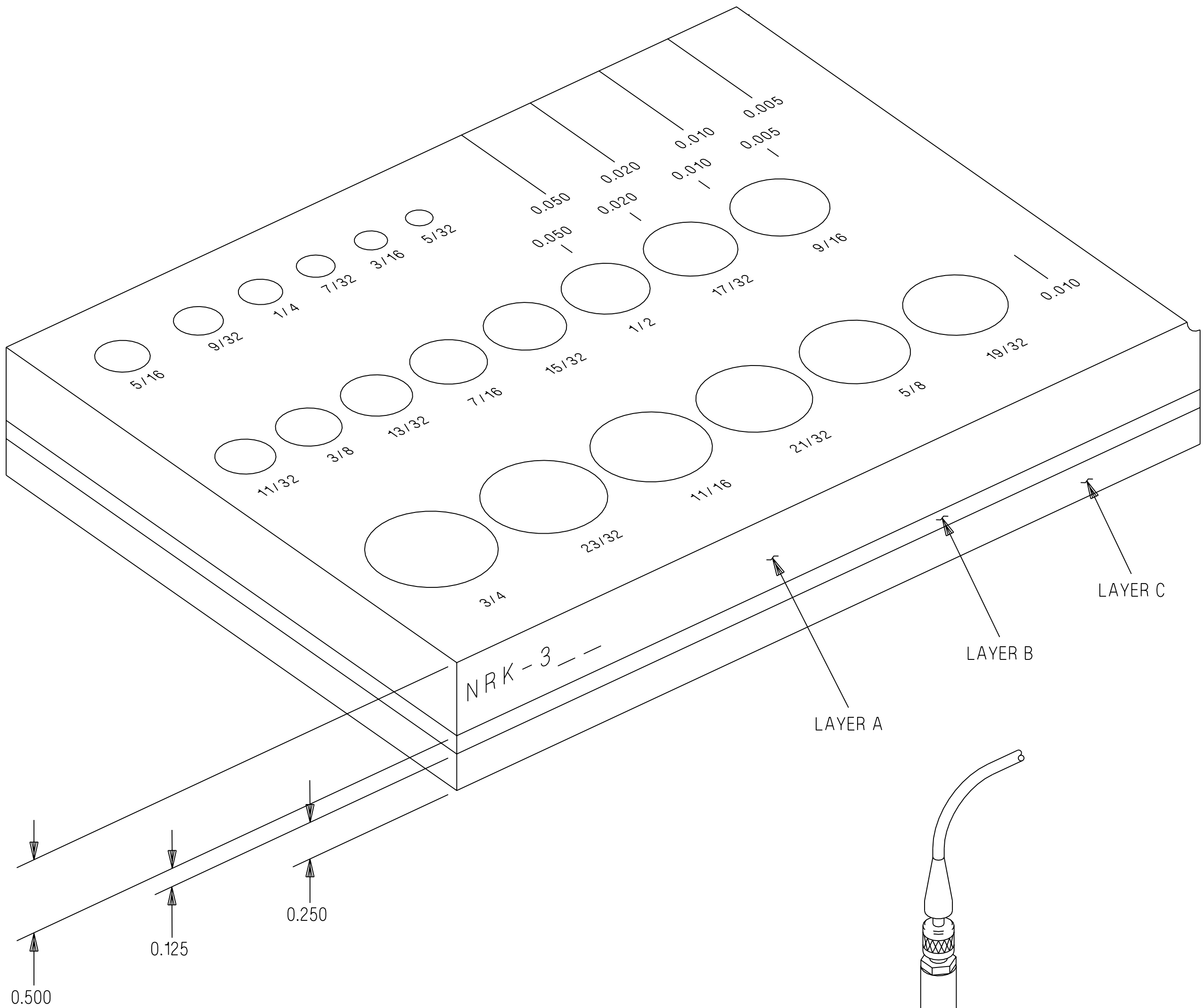
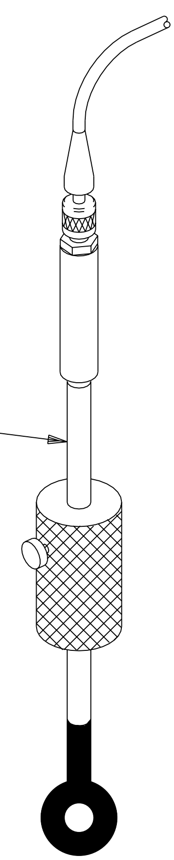


Figure 1. NDT-25N Eddyscope





NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-A3L ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

ADA792-486-1-039

Figure 2. Eddy Current Reference Standard

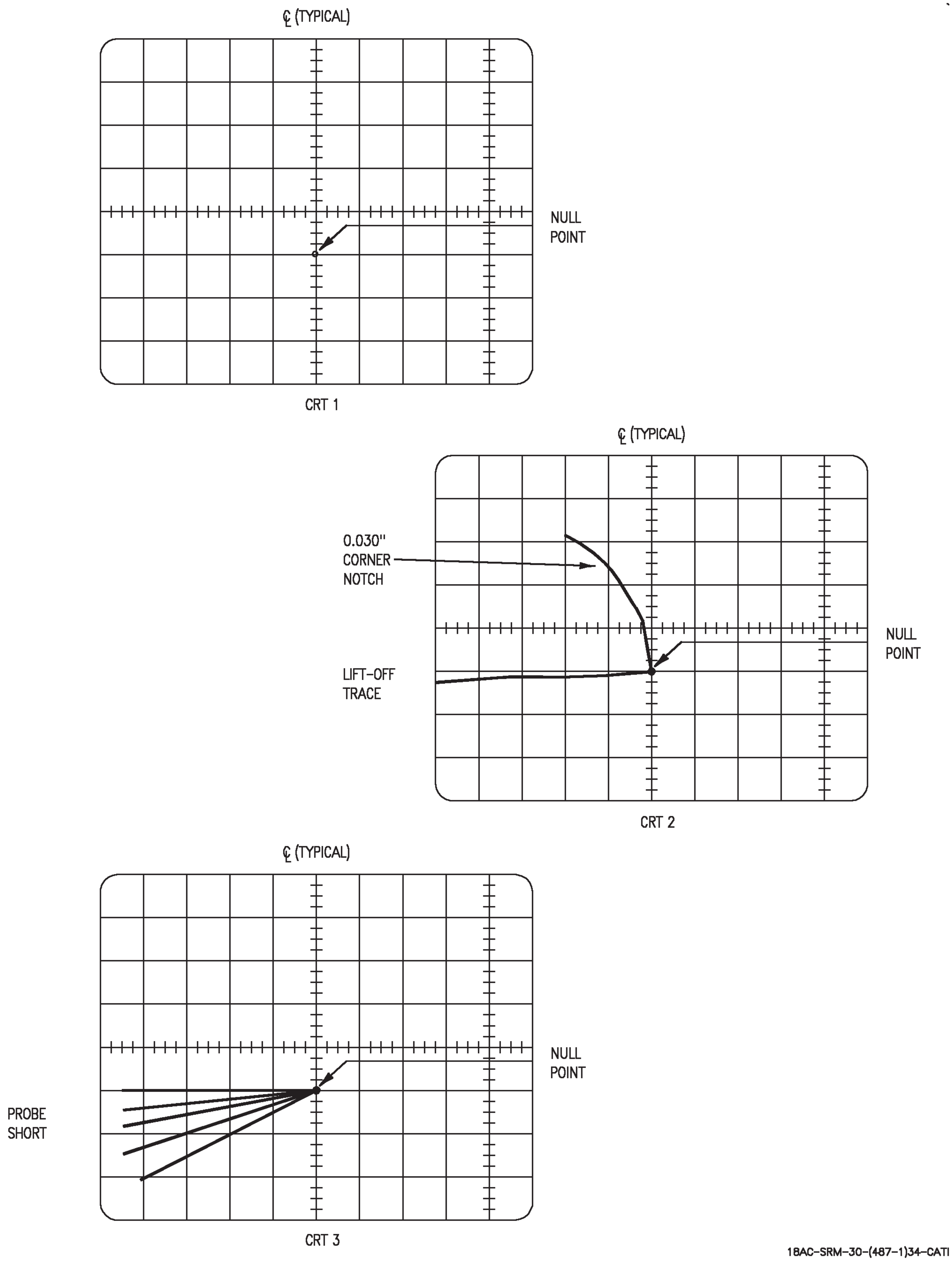


Figure 3. CRT Displays From Standardization/Inspection With NDT-25N Eddyscope

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

Reference Material

Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Ultrasonic inspection method uses sound waves with frequencies that are above audible range. High frequency sound is induced into parts being inspected by using transducer. This ultrasonic energy travels through part. Any marked changes in acoustic properties; defect, interface, or back surface will reflect sound back to transducer. This information is normally displayed on oscilloscope. Correct selection of transducer, sensitivity, angle and so forth, will enable inspection of surface, subsurface, and back surface of part.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores have been met (A1-F18AC-PCM-000).

4. ULTRASONIC CALIBRATION AND INSPECTION PROCEDURE FOR SKIN TO CORE UNBONDS.

5. Ultrasonic waves are used to inspect bondline integrity between honeycomb and composite or metal skins. This method is not applicable to doubler or tripler to core bonds.

Support Equipment Required

Part Number or Type Designation	Nomenclature
C-398	Ultrasonic Flaw Detector
57A4244-30	Ultrasonic Test Block, IIW, Type 2, Aluminum

Materials Required

NOTE

Alternate item specification or part number is shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II	Couplant Aircraft
MIL-G-81322	Grease
MIL-P-83953-2, TYPE 1, CLASS A or B, RED OR BLACK	Aircraft Marking Pencil

6. **EQUIPMENT CALIBRATION.** See figure 1.

a. Connect transducer(s), used in specific procedure work package, to tester.

b. Turn FREQUENCY to frequency of transducer(s) used in specific procedure work package.

c. Turn tester ON, allow 15 minutes warmup.

d. Time-base calibration, straight beam transducers.

(1) Apply couplant to test block. See figure 1.

(2) Position transducer(s) on test block to get 4 inches of metal travel.

(3) Adjust RANGE and SWEEP DELAY until response of approximately 40 percent horizontal screen distance is received on tester. See fugure 1, CRT 1.

e. Time-base calibration, angle beam transducers.

(1) Apply couplant to test block. See figure 1.

(2) Position transducer on test block to get 4 inches of metal travel. Transducer may be moved slightly to maximize response.

(3) Turn RANGE and SWEEP DELAY until response of approximately 40 percent horizontal screen distance is received on tester. See figure 1, CRT 2.

f. Time-base calibration, surface wave transducers.

(1) Apply couplant to test block. See figure 1.

(2) Position transducer per figure 1, except nose of transducer should be 4 inches from edge of test block. This is the calibration point.

(3) Turn RANGE and SWEEP DELAY until response of approximately 40 percent horizontal screen distance is received on tester. See CRT 2.

g. Adjust GAIN or ATTENUATION to get suitable signal height. Turn REJECT OFF.

NOTE

With equipment having tuning controls, turn TUNING to maximize response.

h. Adjust DAMPING to get most distinct peak while keeping unwanted signals to minimum. CRT presentation should now appear as shown on figure 1, CRT 1 or CRT 2.

7. **INSPECTION CALIBRATION.** If calibration standards are not specified in specific procedure work package, go to step d of this paragraph. If standards are specified, calibrate as below.

a. Apply couplant to calibration standard specified in specific procedure work package.

b. Position transducer(s) on calibration standard specified in specific procedure work package.

c. Angle beam, surface wave, and straight beam pulse-echo reference standard calibration.

(1) Position transducer on known good area of reference standard.

(2) Adjust RANGE, SWEEP DELAY, and ATTENUATION controls to get response similar to figure 2, CRT 1.

(3) Move transducer over known defect areas and look for responses similar to figure 2, CRT 2 and CRT 3.

d. Through transmission reference standard calibration.

(1) Position transducers over known good area of standard.

(2) Adjust RANGE, SWEEP DELAY, and ATTENUATION controls to get response similar to figure 3, CRT 1.

(3) Move transducers to maximize response height and readjust ATTENUATION or GAIN to get response of 70 to 90 percent of CRT height.

(4) Move transducers directly over known defect areas and look for responses similar to figure 3, CRT 2.

(5) Move transducers until their centers are at edge of defect areas and observe increase in response height. See figure 3, CRT 3.

e. If reference standard calibration is only calibration specified in specific procedure work package, go to paragraph 8. If calibration points have been specified in specific work package, continue as below.

f. Apply couplant to calibration point(s) specified in specific procedure work package.

g. Position transducer(s) at calibration point(s) specified in specific procedure work package.

(1) For angle beam and surface wave pulse-echo inspections, rotate transducer until honeycomb core ribbon direction is determined. Ribbon direction is direction of aluminum foil ply in honeycomb core. See figure 4. Response will be maximum with transducer in this direction. During all searches, transducer should be directed or aimed in this maximized direction, without respect to searching or indexing directions.

NOTE

With through transmission techniques, maximized response with unaligned transducers is possible indication of unbonds or delaminations. Inspect for core alignment with respect to skins, since this may also produce this condition.

(2) For through transmission inspections, align transducers to maximize response. Transducers alignment must be maintained during inspection.

h. Adjust ATTENUATION or GAIN until CRT response with transducer over calibration point, good bond area, is approximately 70 to 90 percent full screen height with leading edge of response at approximately 50 percent of horizontal scale, see figure 2, CRT 1 or figure 3, CRT 1. Use maximum REJECT to clean up the baseline.

i. Mark envelope height and position of good bond response lightly on scope face as reference point.

j. At settings established in paragraph 7, step h, move transducer(s) over adhesive area indicated for part, observe drop in response or complete loss of signal. CRT should appear as shown on figure 2, CRT 2 and figure 3, CRT 2. These CRT's are typical of unbond or delamination response where total loss of signal also occurs.

8. **INSPECTION PROCEDURE.** To make sure of complete inspection of part, grid pattern is marked on surface of part. Each grid is inspected using directions of index, search, and grid size specified in specific procedure work package.

a. Layout grid pattern on part to be inspected.

b. Maximize response in inspection area.

(1) For angle beam and surface wave pulse-echo arrangements, make sure honeycomb core ribbon direction has been determined and that response amplitude is established along this maximized response direction. Keep transducer oriented in this direction without respect to searching and indexing directions. See figure 4.

NOTE

With through transmission techniques, maximized response with unaligned transducers is possible indication of unbonds, delaminations, or distorted core. Inspect core alignment with respect to skins using radiographic method.

(2) For through transmission arrangement, maximize response by slightly adjusting position of transducers. Visually make sure transducers are aligned when maximized response is received. Maintain transducer alignment during inspection.

c. Searching rate during inspection should not exceed rate of search used in detecting simulated unbonds. If directions are not shown in specific

procedure work package, search parallel to core splices, thickness changes and closeouts to avoid interpretation errors in that area. If examination of part skins shows ripples, ridges, or other surface flaws, search in direction of flaws to make sure of maintaining transducer contact. Search all area within one grid before inspecting next grid.

d. Dimension of index between each linear search should be as listed below. Dimensions listed are in inches.

Delamination Diameter	Maximum Index
0.250	0.063
0.300	0.094
0.370	0.125
0.500	0.125
0.750	0.250
1.000	0.375

e. Inspect 100 percent of bondlines specified using figures 2 and 3 representative CRT's as interpretation guides and information below.

(1) When core has been damaged or cut, horizontal response will move left for pulse-echo tests and will fall to zero for through transmission tests.

(2) As transducer(s) is/are moved toward shorter core heights in tapered honeycomb section, response will move left on CRT.

(3) For pulse-echo techniques, two envelopes may appear on CRT simultaneously when transducer(s) are half on and half off damaged core. See figure 2, CRT 4. That is, additional envelope will appear to left of normal envelope at distance between normal and initial pulse, proportional to distance of break.

(4) As transducer(s) is/are moved over machined step, such as leading edge flap skin, amplitude of envelope will decrease. Searching across such thickness changes should be avoided to make sure that loss in amplitude is not misinterpreted as defect. Use straight edge to avoid searching across such thickness changes.

(5) Searching across areas with extra layers of adhesive may remove or significantly reduce good bond response. Also, ribbon direction may not be parallel on opposite sides of core splices. A radiographic inspection of part can be used to determine if these conditions exist.

f. Mark all areas where response levels significantly decrease. Verify coupling and inspection procedures to make sure correct test has been made. Repeat inspection on adhesive areas. Verification and measurements should be as below.

(1) Clean off all excessive couplant. Apply minimum of new couplant, outlining defect using scribed line on each side of transducer as zero reference.

(2) To map edge of defects larger than face of transducer, move transducer(s) slowly toward edge of defect until response from good bond areas decrease in height to about half level. See figure 2 and 3, CRT 3.

(3) Make mark on surface of part being inspected at centerline of transducer and continue to map defect edges.

(4) As transducer(s) is/are moved away from center of defect, amplitude will increase. When amplitude is one half of that received in no defect area, mark surface of part being inspected at center of transducer. Continue this until all defects are mapped.

(5) When screen response is lost during searching, verify coupling and transducer(s) face wear. More or heavier couplant may be used if required.

(6) Areas with extra adhesive, surface filler material, or repairs may have decreased response amplitude. Surface filler material may also cause response to move toward right on CRT horizontal baseline. Slower velocity in filler material; sound waves slow down while traveling through filler material, moving response farther out in time.

(7) Review radiographs of part to determine if extra adhesive, surface filler material, or repairs exist in area of defect. If these conditions exist at same position and have same size as ultrasonic indications, area should not be considered defect. If none of these conditions exist in area of defect and coupling is verified, indication should be considered defect.

g. With aircraft marking pencil, mark size, shape, and location of defect(s) on surface of part and record.

h. Clean couplant from part.

9. CALIBRATION AND INSPECTION PROCEDURES FOR ULTRASONIC INSPECTION OF COMPOSITE LAMINATES.

a. Select transducer specified in specific procedure work package.

b. When thickness gage without CRT presentation is used in specific procedure work package, refer to operational manual for calibration of ultrasonic unit being used. When CRT presentations are used, continue as below.

c. Unless specified in specific procedure work package, select calibration standard with approximate thickness range of part to be inspected. See figure 5 and below instructions.

(1) See detail A. Part having simulated delamination such as flat bottom machined hole. Delamination can be simulated by striking laminate with hammer. Use contact inspection methods to determine amount of delamination.

(2) See detail B. Step wedge with step thickness comparable to area being measured or tested.

(3) See detail C. Metal calibration block, similar to those used for straight beam inspection.

(4) See detail D. Extension of part being tested. Use finger damping to make sure of part continuity and measure thickness mechanically.

NOTE

Metallic wedge may be used, but depth accuracy is lower. Velocity of graphite epoxy is about one half that of aluminum, steel or titanium. Velocities in graphite epoxy have been found to vary up to ±10 percent, so exact measurements of depth and thickness are not possible.

d. Adjust MATERIAL CALIBRATION or VELOCITY, SWEEP DELAY, and RANGE until digital readout or CRT response is proportional to actual thickness when transducer is coupled to part being inspected. See figure 6, CRT 1 through 4. Place transducer on standard and adjust GAIN until CRT response similar to figure 6, CRT 5 is received.

e. Search part being inspected in area of suspected defect. Search rate is 1 or 2 feet per minute. Index approximately 1/2 transducer diameter per search.

f. If large area is to be inspected, mark 6 X 6 inch grid and complete inspection in one grid before inspecting next.

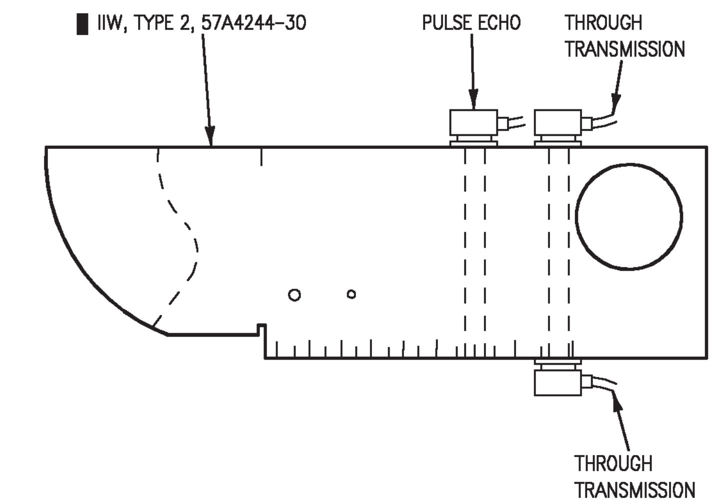
g. Delaminations are indicated by unexplainable thickness changes or new responses before back surface responses. Loss of all responses can also indicate delamination. See figure 6, CRT 6 through 12 for additional interpretation of CRT responses.

h. Always make sure of coupling before marking defect.

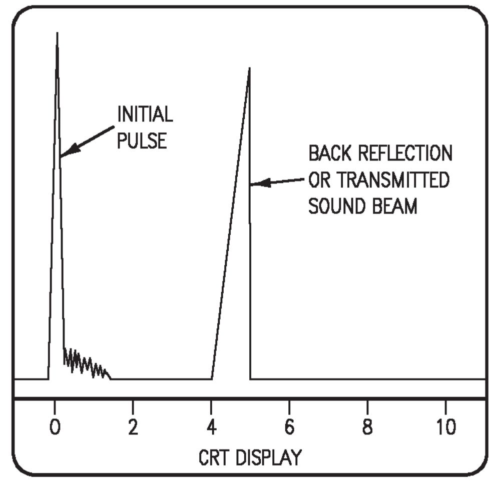
i. Determine defect(s) size and depth.

j. With aircraft marking pencil, mark defect(s) on surface of part and record.

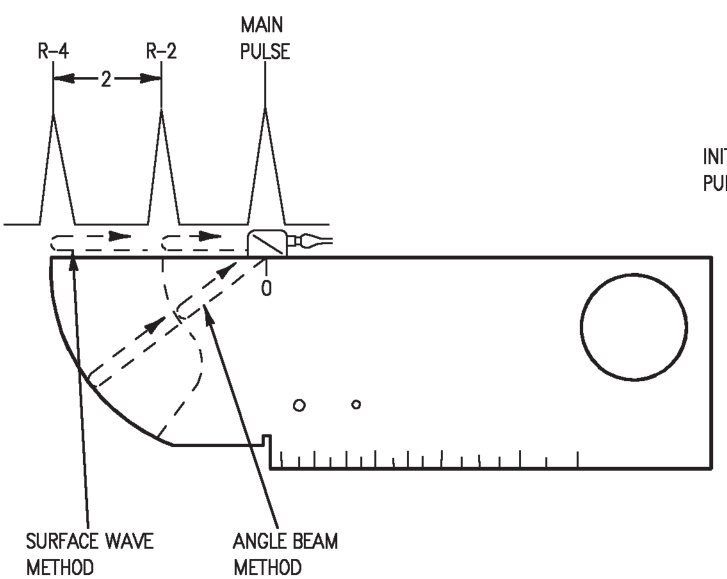
k. Clean couplant from part.



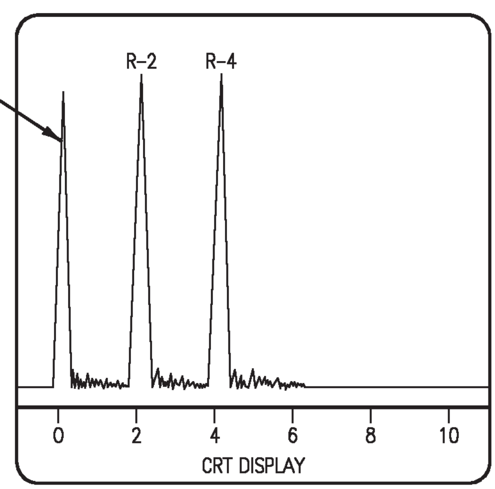
STRAIGHT BEAM TRANSDUCER DISTANCE CALIBRATION



CRT 1



ANGLE BEAM AND SURFACE WAVE TRANSDUCER DISTANCE CALIBRATION



CRT 2

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Figure 1. Equipment Calibration

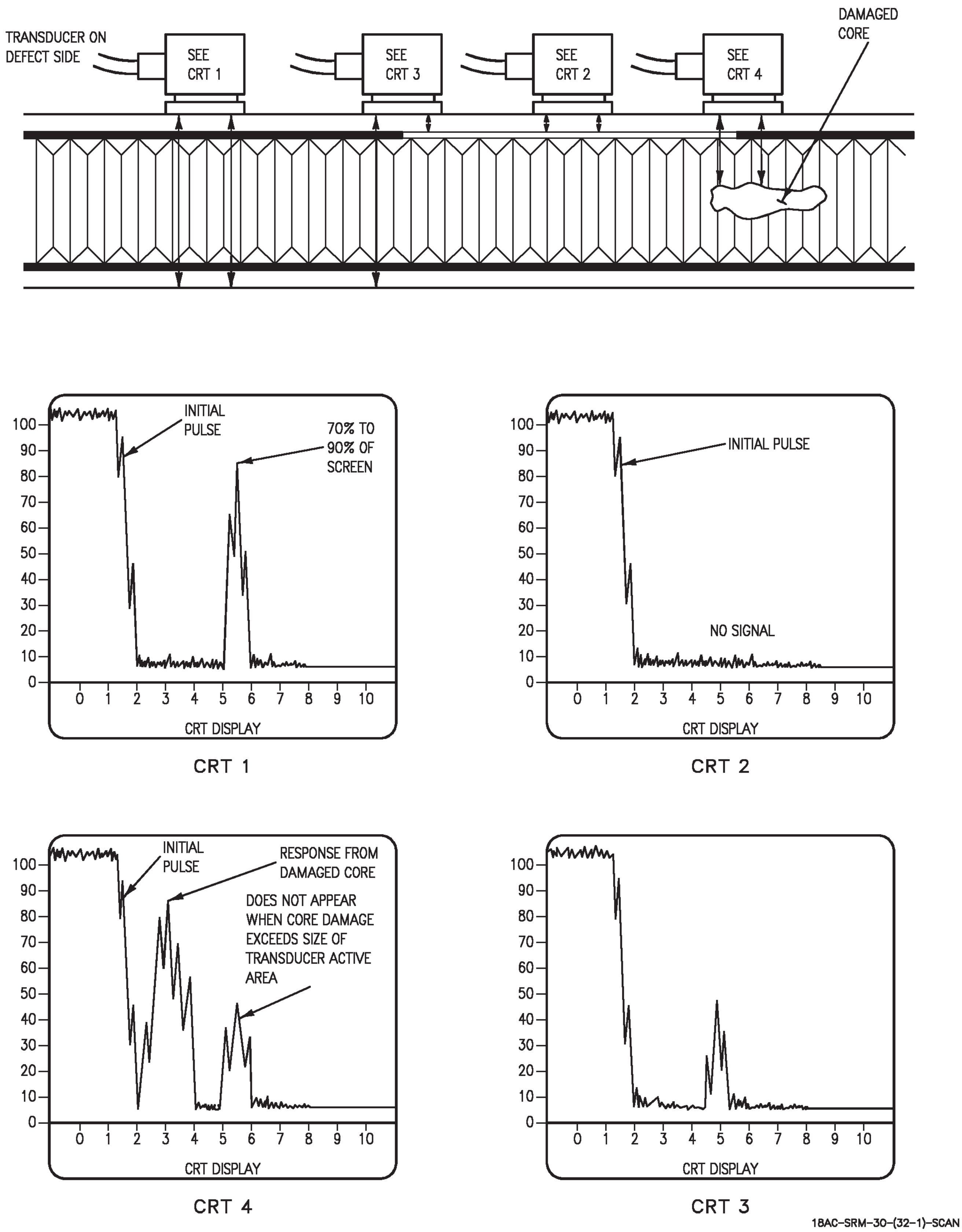


Figure 2. Pulse-Echo Ultrasonic Inspection of Skin to Core Unbonds

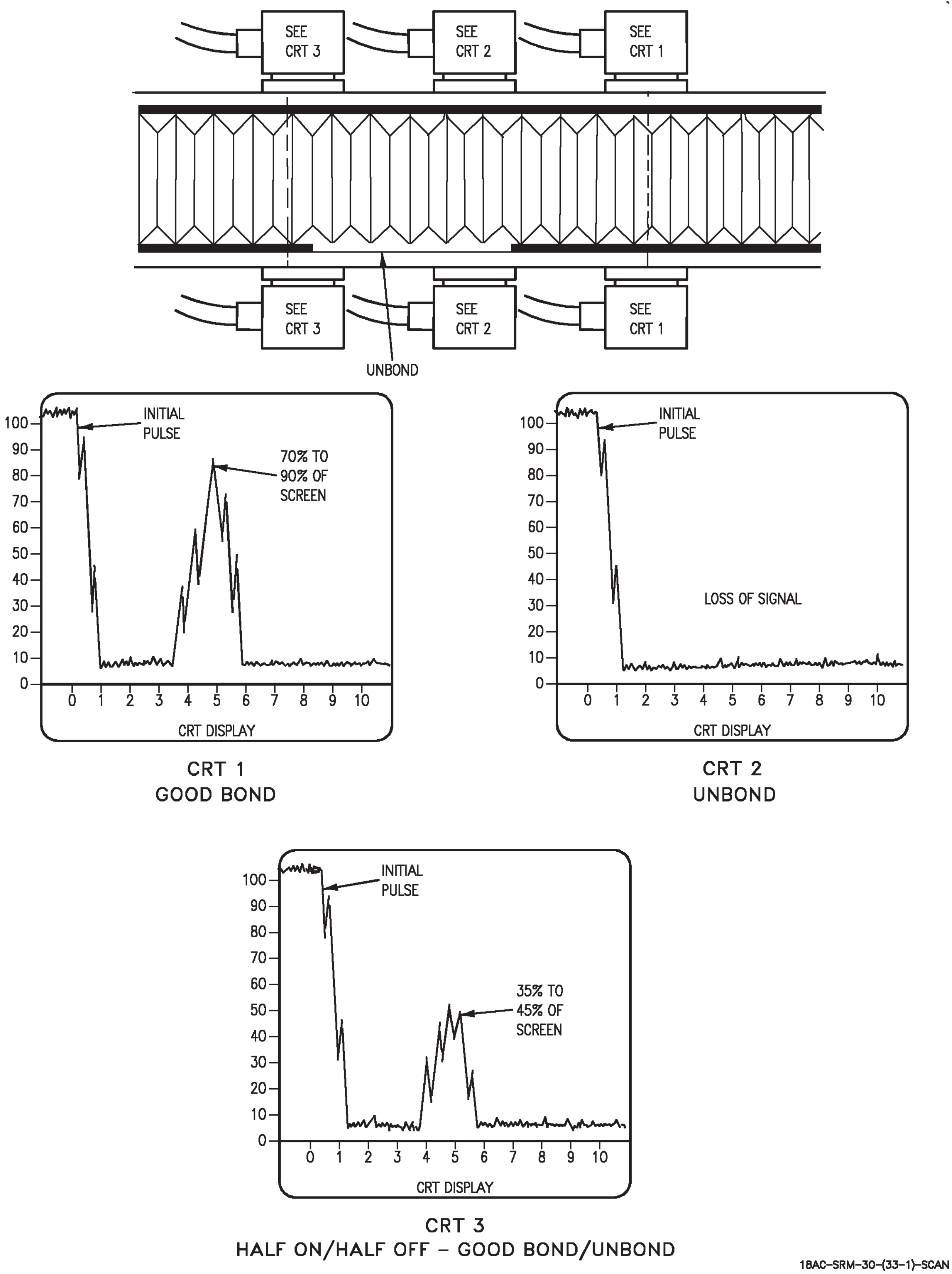
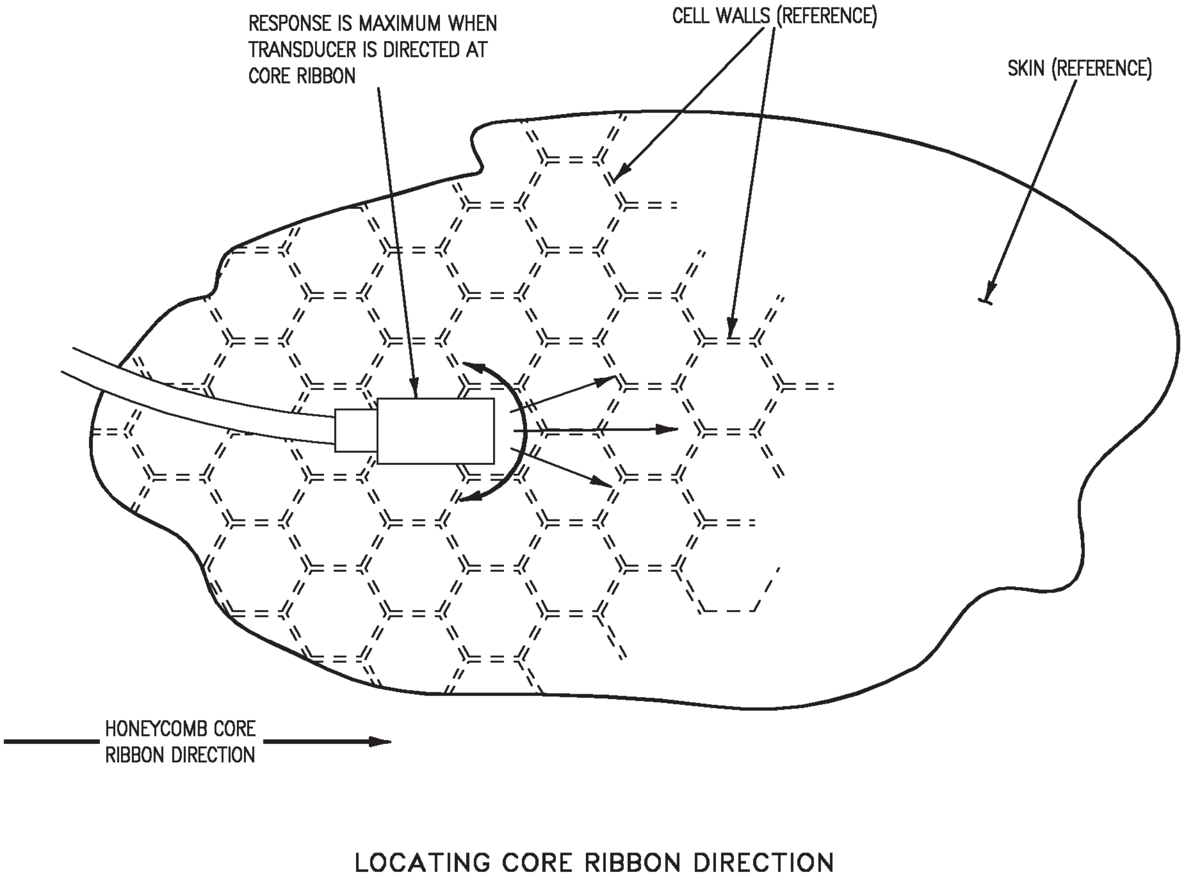
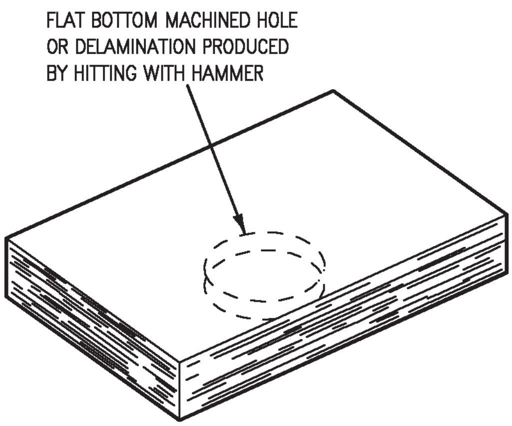


Figure 3. Through Transmission Ultrasonic Inspection of Skin to Core Unbonds



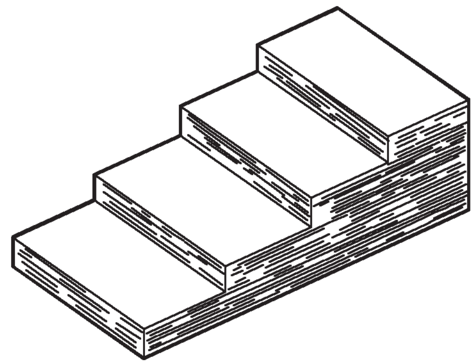
18AC-SRM-30-(34-1)-CATI

Figure 4. Honeycomb Core Ribbon Direction



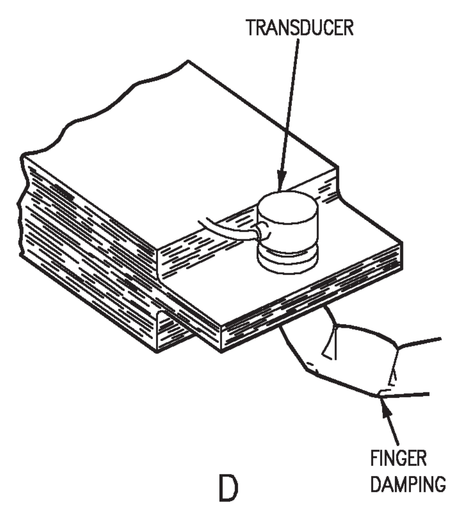
A

COMPOSITE LAMINATE WITH
SIMULATED DELAMINATION



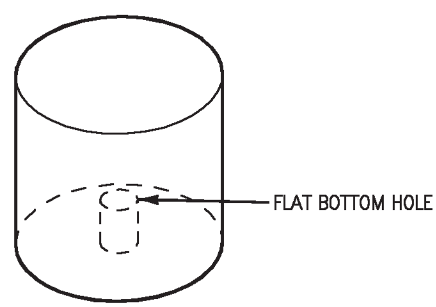
B

COMPOSITE LAMINATE STEP WEDGE



D

CALIBRATION USING EXTENSION OF PART

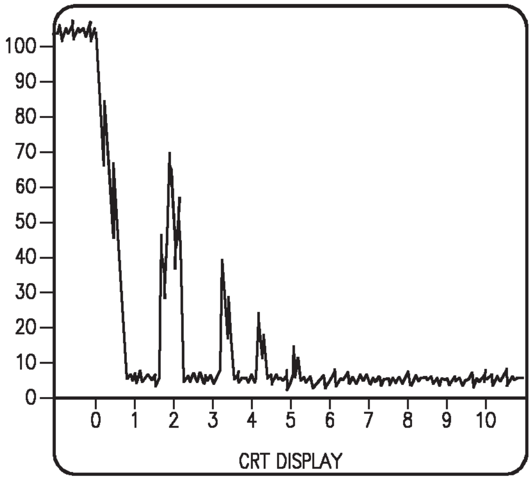


C

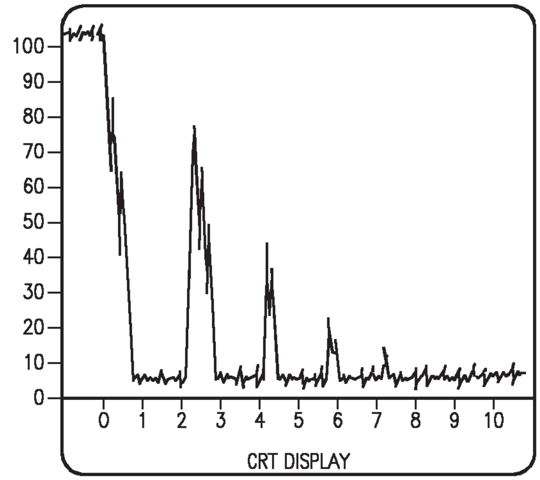
METAL CALIBRATION BLOCK AS DESCRIBED
FOR STRAIGHT BEAM INSPECTION

18AC-SRM-30-(35-1)21-SCAN

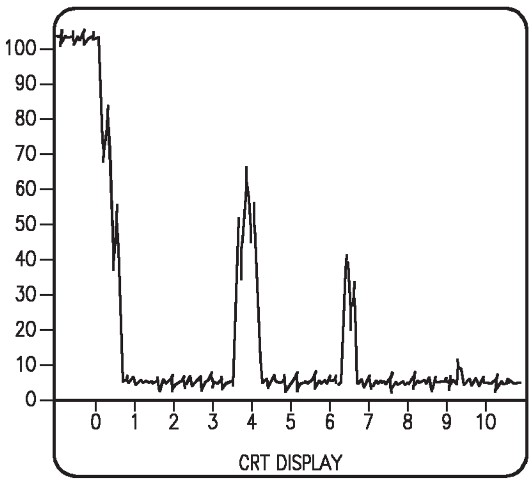
Figure 5. Calibration Standards for Composite Laminates



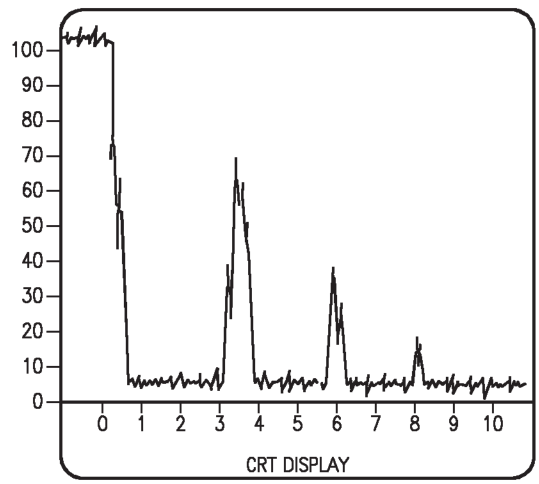
CRT 1



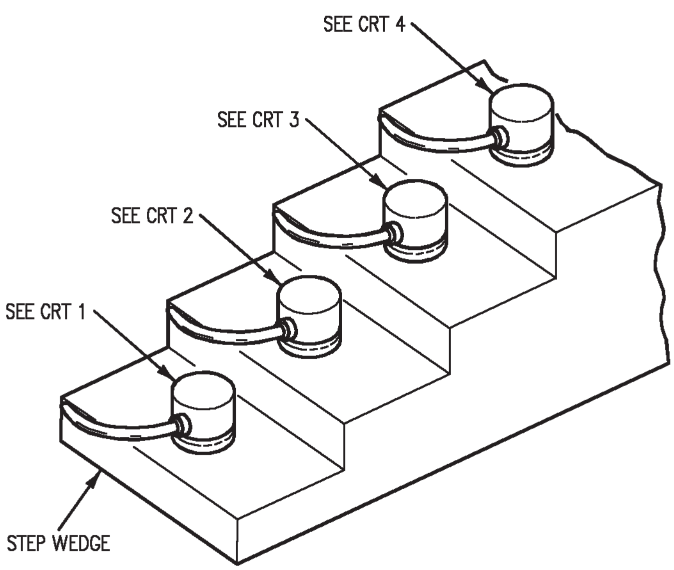
CRT 2



CRT 4



CRT 3



LEGEND

CALIBRATION FOR DEPTH DETERMINATION OF DELAMINATION

1. SET RANGE KNOB TO 1/2–TO 1 INCH FULL SCALE AS APPLICABLE.

2. ADJUST GAIN, MATERIAL CALIBRATION, DELAY, AND REJECT TO GET CRT PATTERNS SIMILAR TO CRT 1 THROUGH 4.

3. FOR THICKNESS GAGES WITHOUT CRT DISPLAYS, ONE SAMPLE THICKNESS IS USUALLY ENOUGH FOR CALIBRATION. REFER TO OPERATION MANUAL FOR APPLICABLE GAGE TO DETERMINE IF ONE SAMPLE IS ENOUGH. THIS CONDITION IS COMMON TO GAGES HAVING NO DELAY AND TRIGGER ON FIRST BACK REFLECTION AND MEASURE ON FIRST AND SECOND BACK REFLECTION.

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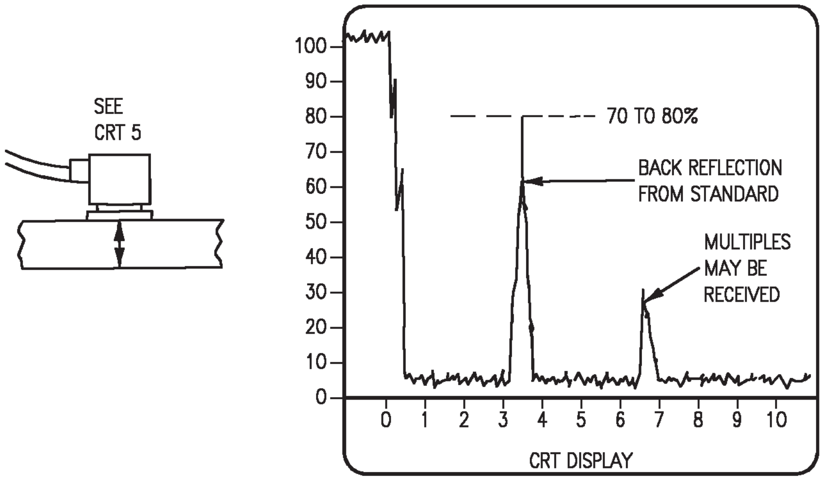
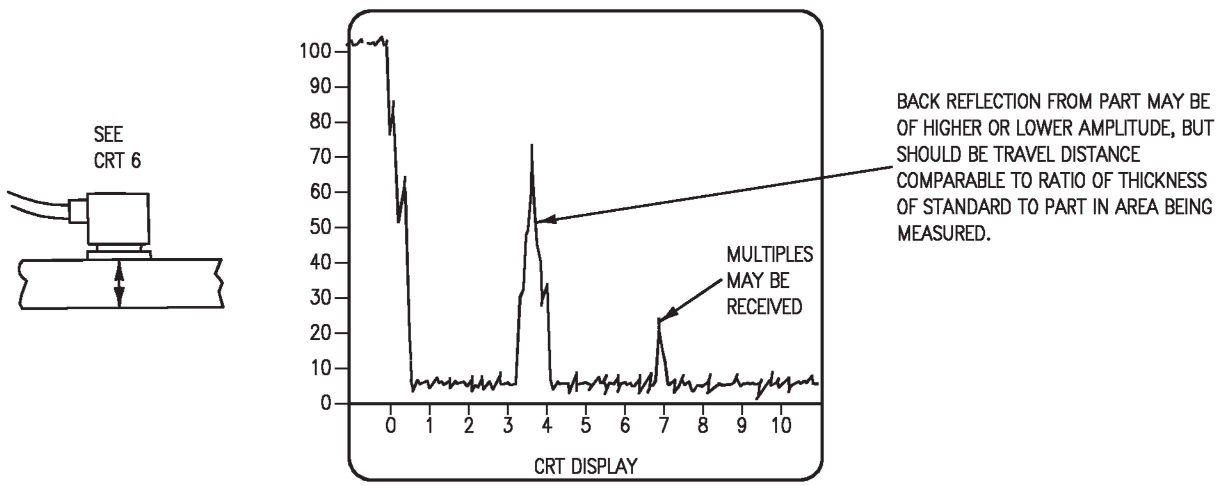
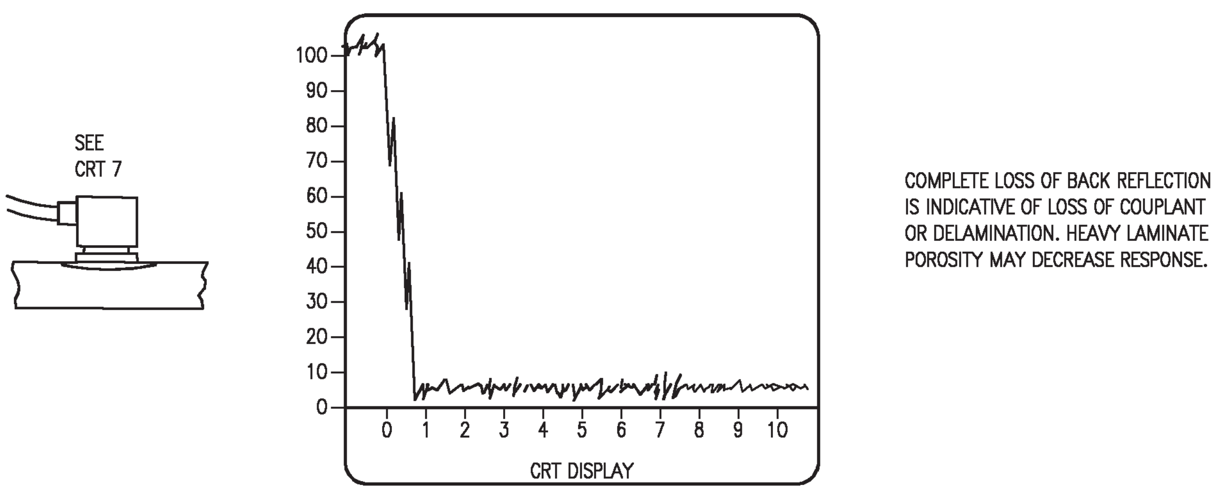
Figure 6. Ultrasonic Inspection of Composite Laminates (Sheet 1)



CRT 5



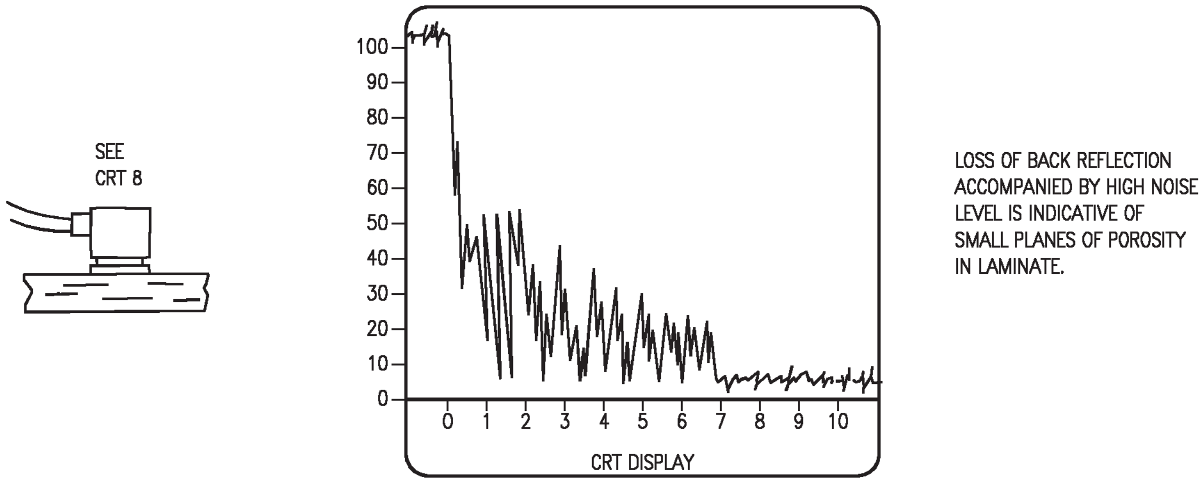
CRT 6



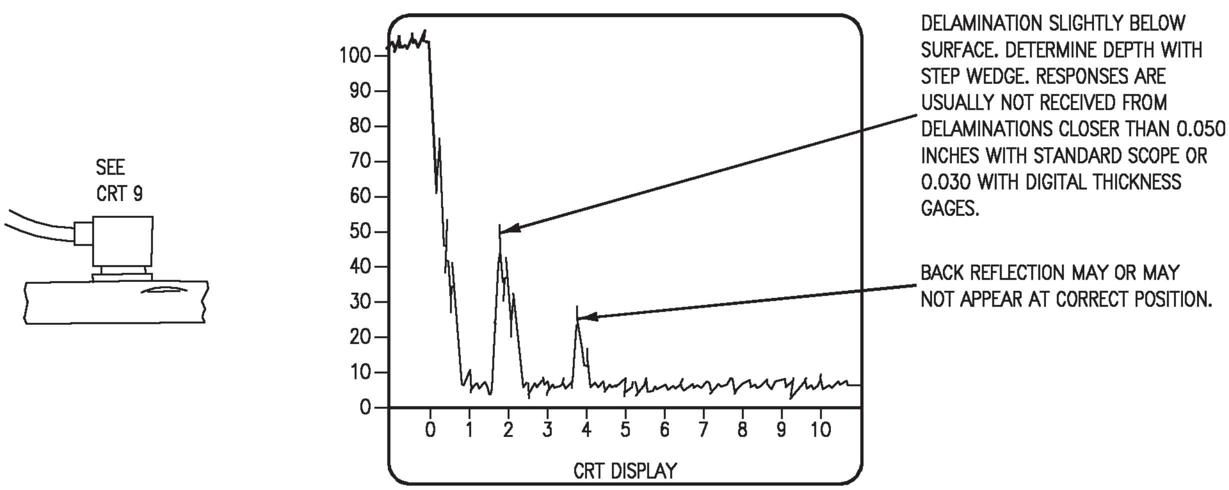
CRT 7

18AC-SRM-30-(36-2)34-SCAN

Figure 6. Ultrasonic Inspection of Composite Laminates (Sheet 2)



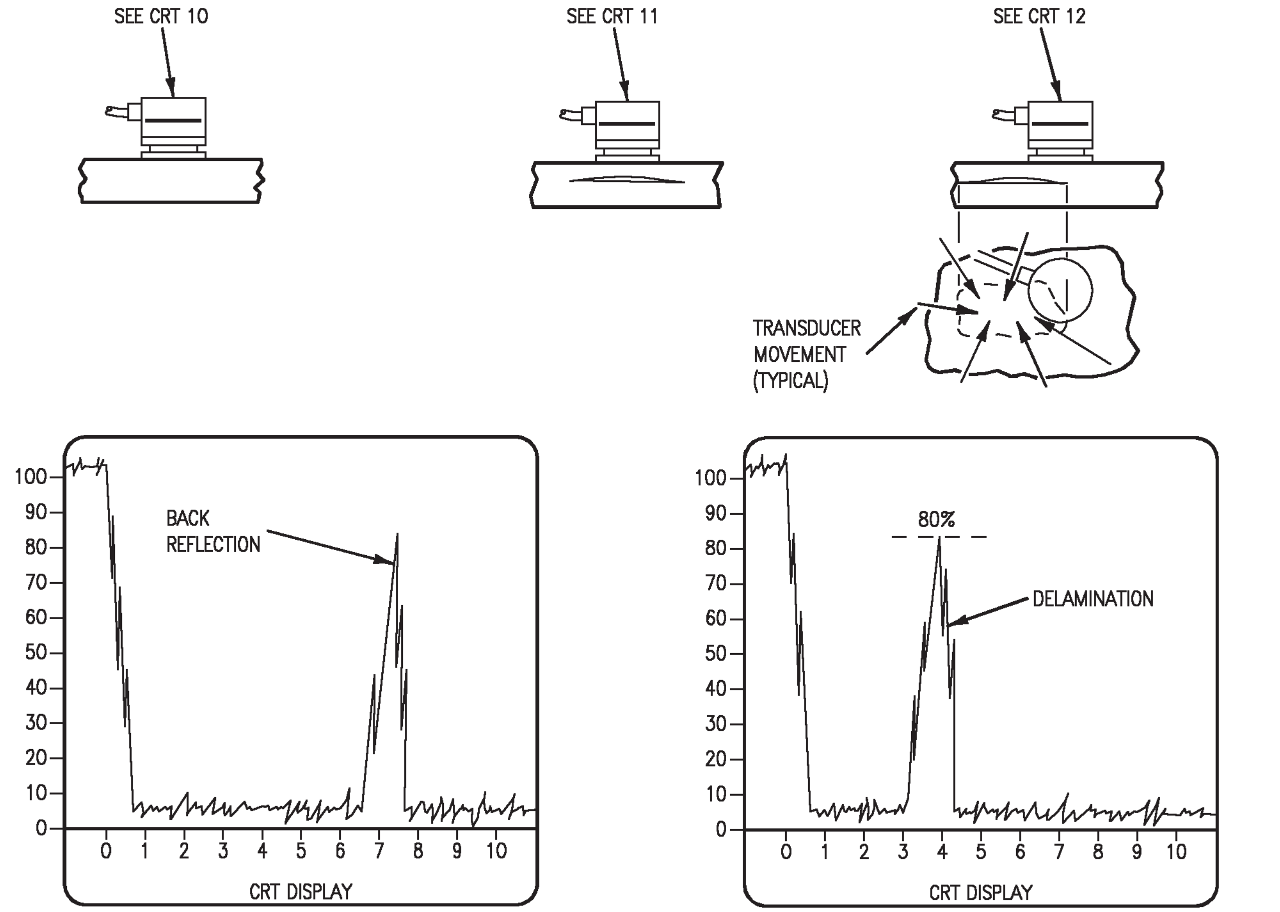
CRT 8



CRT 9

18AC-SRM-30-(36-3)21-SCAN

Figure 6. Ultrasonic Inspection of Composite Laminates (Sheet 3)



CRT 10

CRT 11

LEGEND

HALF AMPLITUDE MAPPING TECHNIQUE

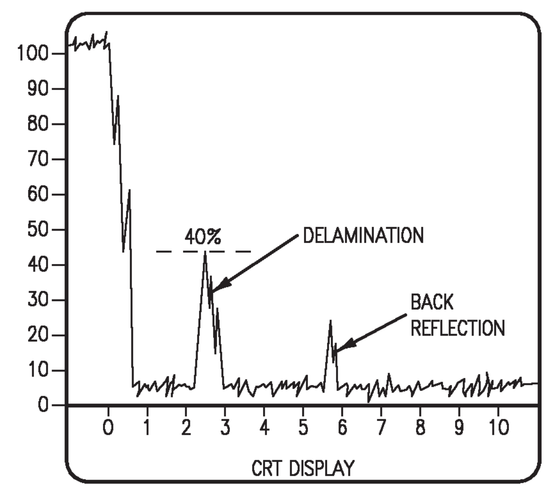
1. LOCATE DELAMINATION. SEE CRT 10.

2. ADJUST GAIN UNTIL MAXIMIZED DELAMINATION. RESPONSE APPROXIMATES 80 PERCENT OF CRT HEIGHT. SEE CRT 11.

3. MOVE TRANSDUCER TOWARD CENTER OF DELAMINATION IN ALL DIRECTIONS. MARK SURFACE OF PART UNDER CENTER OF TRANSDUCER WHEN AMPLITUDE OF DELAMINATION RESPONSE REACHES 1/2 MAXIMUM HEIGHT. SEE CRT 12.

4. WHEN DELAMINATION IS SUPERFICIAL AND NO RESPONSE IS RECEIVED, USE SAME TECHNIQUE, BUT SET REFLECTION BACK TO 80 PERCENT. MARK SURFACE OF PART UNDER CENTER OF TRANSDUCER WHEN BACK REFLECTION FALLS TO 40 PERCENT.

5. FOR DIGITAL THICKNESS GAGES, USE SAME TECHNIQUE, BUT MARK SURFACE OF PART UNDER CENTER OF TRANSDUCER WHEN RESPONSE BEGINS TO CHANGE AS TRANSDUCER MOVES TOWARD CENTER OF DELAMINATION.



CRT 12

18AC-SRM-30-(36-4)21-SCAN

Figure 6. Ultrasonic Inspection of Composites Laminates (Sheet 4)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

ULTRASONIC THROUGH TRANSMISSION CONTACT TESTING, STANDARDIZATION, AND INSPECTION PROCEDURES FOR COMPOSITE LAMINATE SKINS BONDED TO HONEYCOMB CORE

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. ULTRASONIC INSPECTION.

2. Ultrasonic waves are used to inspect composite and metallic skin to honeycomb bond line integrity. In through transmission mode, transmitting search unit, or transducer, introduces sound into part and sound beam is detected by receiving search unit on opposite face of part. Positive response, sensed by receiving search unit, indicates continuous sound path, which is used to verify test area is free from defects within limits of test. Interruptions in sound path by complete blockage, 100 percent signal loss, or large signal reduction indicates presence of defect(s) or materials which cause changes in acoustic properties.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable two Reqd
57A2214 or EQUIVALENT	0°, 0.375 Dia, 225 MHz, SearchUnit Two Reqd
74D110175-1001	Graphite Epoxy Reference Standard Set
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
DISTILLED WATER COMMERCIAL (O-C-265)	Distilled Water

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cables.

b. Attach BNC end of connecting cables to T and R BNC jacks on ultrasonic flaw detector (tester).

c. Turn tester ON, allow 15 minutes warm-up.

d. Set tester front face settings;

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COARSE SWEEP RANGE, FREQ, FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. Optimum setup may produce changes in these initial settings.

COARSE SWEEP RANGE	1.0 INCH
ATTENUATORS	ALL OUT
FILTER	ON
COARSE SWEEP DELAY	0-3 INCHES
FREQ	SAME AS SEARCH UNITS
MODE	THRU TRANS
FINE GAIN	MAX
COARSE GAIN	APPROX 1
REP RATE	AUTO
FINE SWEEP RANGE	APPROX 0 (MIN)
DAMPING	APPROX 0
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water or cleaning compound moistened cloth as required, to make sure inspection area(s) is free of contamination or foreign material.

f. Allowing to air drying for 15 minutes after cleaning.

g. With search units held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline.

h. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

CAUTION

Do not use grease pencil or otherwise mark on face of CRT filter. Damage to components will occur.

6. **STANDARDIZATION AND INSPECTION OF 1 INCH OR LESS HONEYCOMB CORE SANDWICH ASSEMBLIES.**

7. **Standardization for 1 Inch or Less Honeycomb Core Sandwich Assemblies.** See figure 1. Use 74D111295-1005 honeycomb reference standard set, which is part of the 74D110175-1001 graphite epoxy reference standard set, to complete this standardization.

NOTE

Initial and response pulses shown in figure may differ from actual wave shape.

a. Start with tester front face settings as in paragraph 5, step d. With search units in air or face up on work surface, initial pulse leading edge should be located at zero on CRT horizontal baseline. See figure 2, CRT 1.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to both surfaces of reference standard at calibration point P-1 or P-2 specified in specific procedure work package. See figure 1.

c. Position search units on both surfaces of reference standard at calibration point.

NOTE

If search units are slightly misaligned, received response will be reduced in amplitude and leading edge will be shifted toward 10 on CRT horizontal baseline. See figure 2, CRT 3.

d. Adjust GAIN, HORIZONTAL SWEEP FINE LENGTH, DAMP., AND REJECT to locate leading edge of received response at 4 on CRT horizontal baseline and peak amplitude at 80 to 90 percent CRT height. See figure 2, CRT 2. Make sure search units are correctly aligned by maximizing response height.

e. Adjust FREQ, FILTER, GAIN, and VIDEO DISPLAY to optimize CRT response if required.

f. Position search units on 1.00 diameter crushed core area of reference standard next to specified calibration point and observe reduction in received response or complete loss of received response. See figure 2, CRT 4. If search units are not completely on defective area, response will be received, but leading edge will be shifted slightly toward 10 on CRT horizontal baseline. Leading edge of initial pulse should still be located at zero.

NOTE

During inspection, step g. may be done for suspect areas. In this case, do substep (1) on known good area, move search units to suspect area to do substep (2). Move search units back to known good area to do substep (3), and return search units to suspect area to do substep (4).

g. During inspection more gain may be required for configuration penetration because of extra adhesive, wrinkled honeycomb core, or crushed honeycomb core. Do following sequence to observe good and bad responses relative to setup point:

(1) Position search units back on specific work package calibration point and reproduce through transmission response with peak amplitude at 80 to 90 percent CRT height. See figure 2, CRT 2.

(2) Adjust COARSE/FINE GAIN to decrease gain by 6 dB, or set 2 dB and 4 dB attenuators IN, and observe reduction in received response peak. See figure 2, CRT 5. Even with this reduction in gain, received response should be greater than 10 percent CRT height if area is good.

(3) Adjust COARSE/FINE GAIN to add 6 dB, or set 2 dB and 4 dB attenuators OUT, returning received response to 80 to 90 percent CRT height. See figure 2, CRT 2.

(4) Adjust COARSE/FINE GAIN to add additional 6 dB of gain and observe an increase in received response amplitude. Response should saturate or be greater than 100 percent CRT height if area is good. See figure 2, CRT 6. If area contains crushed core, received response will be less than 5 percent CRT height even with this 6 dB gain added. See figure 2, CRT 7. If search units are on edge or area containing crushed core, reduction in amplitude combined with shift in time of response leading edge toward 10 on CRT horizontal baseline will be observed. See figure 2, CRT 8.

8. **Inspection of 1 Inch or Less Honeycomb Core Sandwich Assemblies.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allowing to air drying for 15 minutes after cleaning.

c. To be sure of full inspection coverage, mark 3.00 X 3.00 inch grid pattern on both surfaces of inspection area using aircraft marking pencil. Make sure grid patterns on both surfaces are correctly aligned with each other.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

d. Apply couplant to both surfaces of inspection area.

NOTE

Initial search unit alignment may be established by maximizing signal response. Search unit alignment must be maintained during inspection. See figure 3 for example of search unit alignment device. Alignment yokes are commercially available.

e. Position search units on both surfaces of inspection area where core height is 1.00 or less.

NOTE

Response from structures consisting of metallic skins bonded to honeycomb core will differ from structures with composite laminate skins.

f. Adjust GAIN to set peak amplitude of received response at 80 to 90 percent CRT height. See figure 4, CRT 1. Make sure inspection area core thickness does not exceed 1.00 inch. As core thickness increases, received response location will move toward 10 on CRT horizontal baseline. See figure 4, CRTs 2 and 3.

g. Using through transmission, scan both surfaces of inspection area. Scan each grid block before moving to next. Be sure to maintain search unit alignment.

h. Use aircraft marking pencil to mark all areas where through transmission response peak drops below 5 percent CRT height, even with addition of 6 dB of gain, or if leading edge of received response is shifted 1 major division toward 10 on CRT horizontal baseline. The 6 dB of gain must be made relative to nearby good area or previously determined good bonded area. Refer to step g. of paragraph 7 for details on interrogating suspect area. A flaw response is similar to figure 2, CRTs 3, 7, 8, and figure 4, CRT 4.

i. Once flaw has been identified, use half amplitude mapping technique described in paragraph 16 to determine size of flaw.

j. Use radiographic method (WP005 00) to determine if above marked area is result of additional adhesive, core splice, or extra layer of foaming adhesive. Radiographs of foaming adhesive and core splices are contained in (WP005 00). Reference standard used to set up this inspection contains extra layer of foaming adhesive and core splice which may be radiographed and used as a guide.

9. **STANDARDIZATION AND INSPECTION OF 1 TO 2 INCHES HONEYCOMB CORE SANDWICH ASSEMBLIES.**

10. **Standardization for 1 to 2 Inches Honeycomb Core Sandwich Assemblies.** Use 74D111295-1003 honeycomb reference standard, which is part of 74D110175-1001 graphite epoxy reference standard set, to complete standardization. Follow

standardization procedure listed in paragraph 7 except start with COARSE SWEEP RANGE at 2.

11. **Inspection of 1 to 2 Inches Honeycomb Core Sandwich Assemblies.** Follow inspection procedure described in paragraph 8 with following exceptions:

a. Make sure inspection area remains within 1 to 2 inch range.

b. Use aircraft marking pencil to mark areas where leading edge response falls below 5 per cent CRT height or is shifted more than 1 large division on CRT horizontal baseline toward 10.

12. **STANDARDIZATION AND INSPECTION OF 2 INCHES OR TALLER HONEYCOMB CORE SANDWICH ASSEMBLIES.**

13. **Standardization for 2 Inches or Taller Honeycomb Core Sandwich Assemblies.** Use 74D11295-1001 graphite epoxy reference standard set, to complete standardization. Follow standardization procedure listed in paragraph 7 except start with COARSE SWEEP RANGE at 5.

14. **Inspection of 2 Inches or Taller Honeycomb Core Sandwich Assemblies..** Follow inspection procedure described in paragraph 8 with following exceptions:

a. Make sure inspection area does not exceed 6 inches in thickness.

b. Use aircraft marking pencil to mark areas where leading edge response falls below 5 percent CRT height or is shifted more than 1/2-large division on CRT horizontal baseline toward 10.

15. **CRT INTERPRETATION.**

NOTE

Make sure of coupling and search unit alignment before marking area as defect.

a. Crushed core. Presence of crushed core will result in absence of received response or large reduction in received response. See figure 2, CRT 4. If search unit does not completely cover area containing crushed core, response will be reduced in amplitude and shifted to left on CRT horizontal baseline. See figure 2, CRT 8.

b. Skin to core unbond. Presence of skin to core unbond will result in complete loss of received response or response less than 5 percent CRT height even when 6 dB of gain has been added compared to P-1 or P-2 calibration point response with 80 to 90 percent CRT height amplitude. See figure 4, CRT 4.

c. Thickness change. As search units are moved across area in which core height is increasing, response will move toward left on CRT horizontal baseline. See figure 4, CRTs 2 and 3.

d. Search unit misalignment. When search units become slightly misaligned, response will be reduced in amplitude and shifted to left on CRT horizontal baseline. See figure 2, CRT 3.

16. **HALF AMPLITUDE MAPPING.** Map defects larger than base of largest search unit used in inspection as follows;

a. Mark preliminary flaw outline where received response falls below 5 percent of level established in inspection procedure. Map size of flaw(s) as noted below:

(1) Verify coupling and correct equipment operation.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

(2) Clean off excessive or dried couplant and reapply minimum of new couplant.

(3) To map edge of defect(s) larger than search unit face, move search unit slowly toward edge of defect until response from nearby good bond area decreases in height to about 1/2-CRT height. See figure 5, CRTs 1 through 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 5.

(4) Make mark on surface of part being inspected at centerline of search unit. Continue mapping edges of defect until defect area is drawn

out on part surfaces. When unbond is detected, length and width dimensions of unbond should be determined during mapping.

b. Make sure search units are aligned during mapping. Slight shift or misalignment may cause inaccurate mapping.

(1) Use radiography to determine presence of previous repairs or extra adhesive.

17. **EVALUATION OF DAMAGED AREAS.** Evaluate damage to composite skins bonded to honeycomb core as follows:

a. Evaluate skin to core bonded areas per applicable paragraphs 5 through 15.

b. Use either couplant listed in this work package or use distilled water as couplant.

c. In localized indentations, surface contours at localized indentations may make coupling of search units impossible. Smaller diameter search units with same or different frequencies may be used to scan the indentation. See figure 6.

d. Local indentations may also contain crushed core. See figure 6. It may be required to increase gain because of attenuation effects of crushed core.

e. Scan at least 2.00 to 3.00 around visible outer edge of damage to make sure any subsurface damage is detected.

NOTE

Patch may already be bonded to damaged assembly.

f. Radiography may be required to detect subsurface crushed core and laminate cracks or to identify any additional adhesive or inconsistent materials detected during ultrasonic inspection.

g. Refer to specific repair work package for patch diameter determination (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

h. If patch diameter exceeds step e. inspection data, do step i.

i. Scan area around outer edge of damage, up to diameter of patch. This will make sure subsurface conditions do not interfere with repair evaluation.

18. **REPAIR EVALUATION.**

a. Evaluate repair of skin to core bonded areas per applicable paragraphs 5 through 15.

b. Use search units specified in this work package or other large diameter search units, up to 1/2-inch diameter with same, higher, or lower frequency.

c. Additional GAIN may be required to penetrate repair area, because repairs usually contain extra adhesive, 1 or more layers of film adhesive, and bonded on patches.

d. After setting time base with HORIZONTAL SWEEP LENGTH, and after setting through transmission received response amplitude with GAIN, using specific reference standard, position search units on patch area near repair. See figure 7.

e. Use GAIN to set received response amplitude at 80 to 90 percent CRT height.

f. Position search units on repair area and adjust GAIN so received response is at 80 to 90 percent CRT height. Up to 32 dB of GAIN may be added to step e. settings. Make sure search units are correctly aligned by maximizing received response.

g. Inspect repair and surrounding patch area. Mark all areas where received response falls below 5 percent CRT height even after 32 dB gain has been added.

h. Use radiographic method (WP005 00) to inspect area 6.00 out from patch periphery for core damage. Inspect same area using through transmission, this work package, to inspect for skin to core unbonds, blown core, or delaminations caused by repair. See figure 8.

19. **ACCEPTANCE CRITERIA.**

20. **Honeycomb Core Sandwich Assemblies Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If information is not included in specific work package, refer to specific work packages in structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of

flaws per area, and criteria for delaminations that overlap zones/areas on part.

21. **Patch Bond Line Flaw Acceptance Criteria.**

a. Flaw/unbond is measured along radial line from center of repair patch. See figure 8.

b. Allowable unbond in patch to core area is determined from repairable unbond criteria of specific procedure work package for part or assembly being replaced.

c. Patch to skin bond area, total flaw/unbond length along any radial line must not exceed 0.31.

d. For multiple flaws, not on same radial line, total flaw area must be 20 percent or less than total patch to skin bond area.

22. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allowing to air dry for 15 minutes after cleaning.

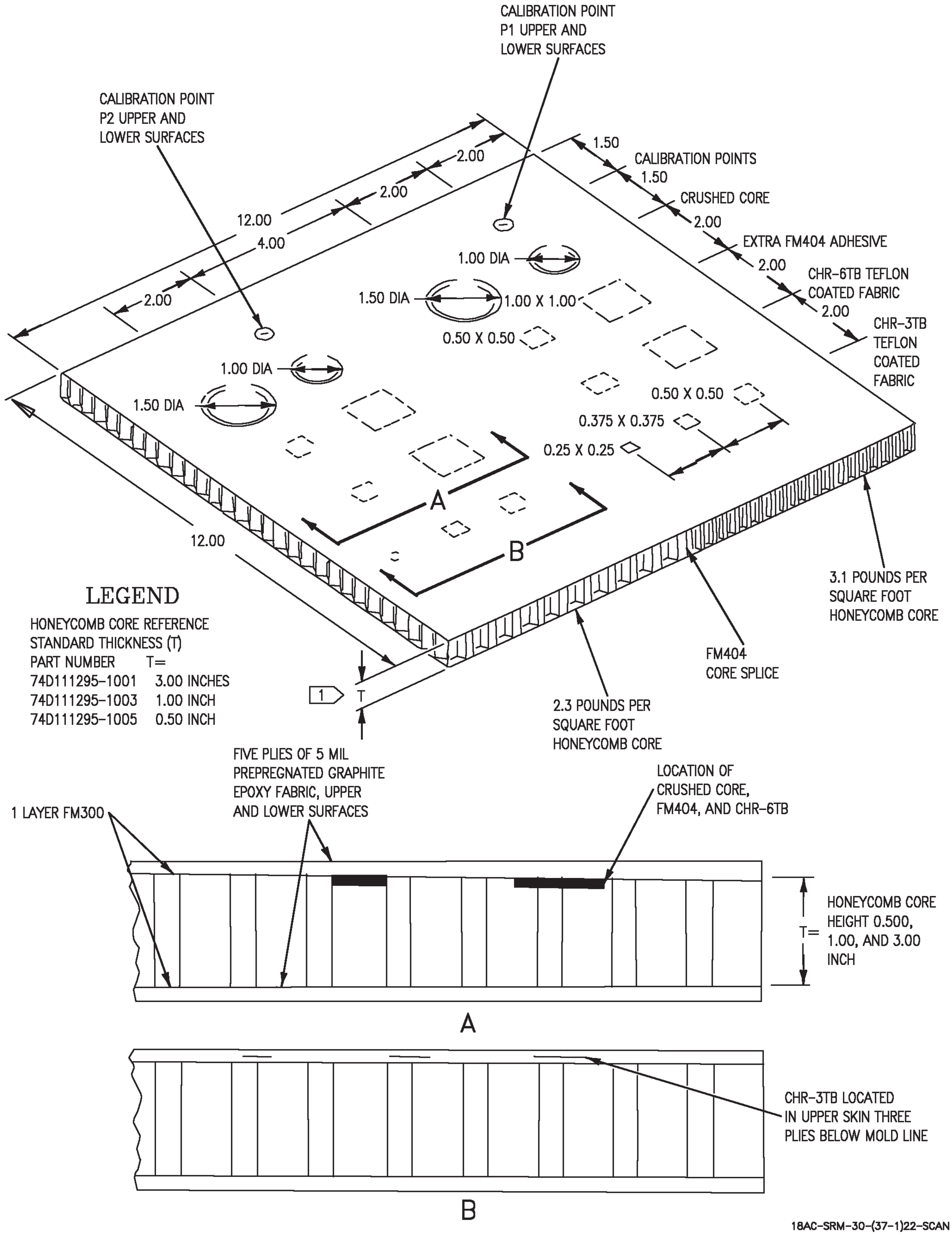


Figure 1. Graphite Epoxy Skinned Honeycomb Core Reference Standard

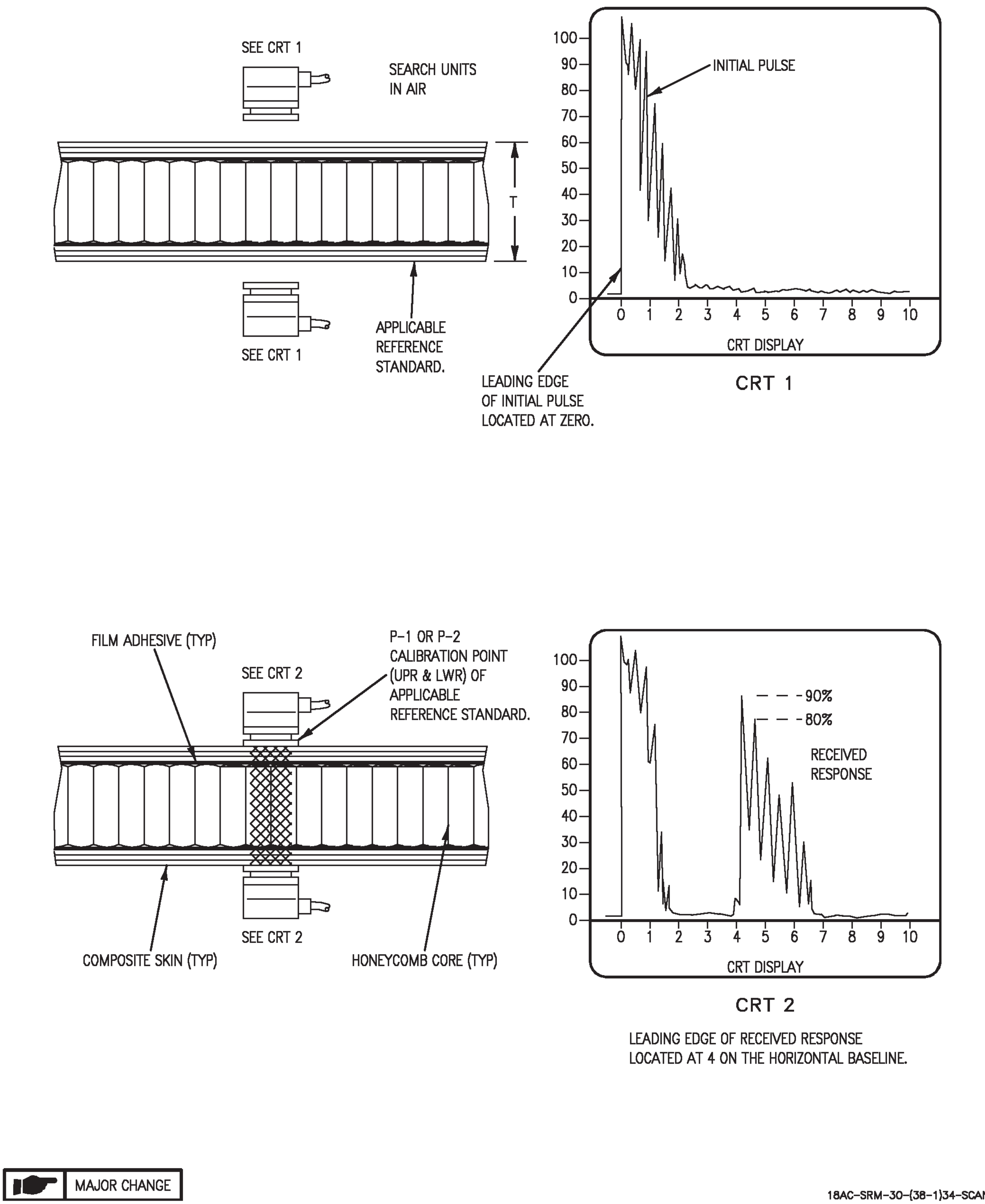
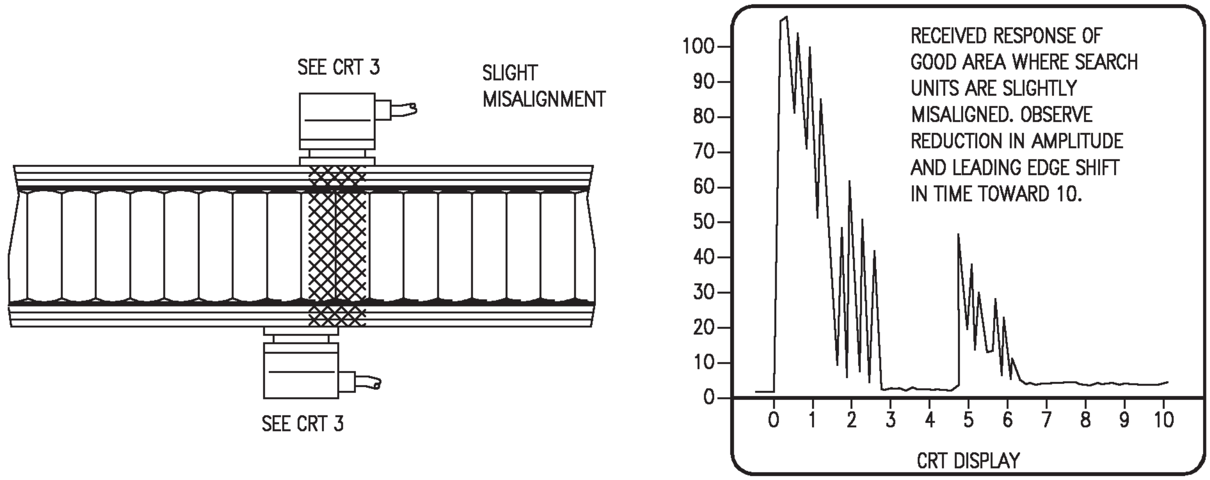
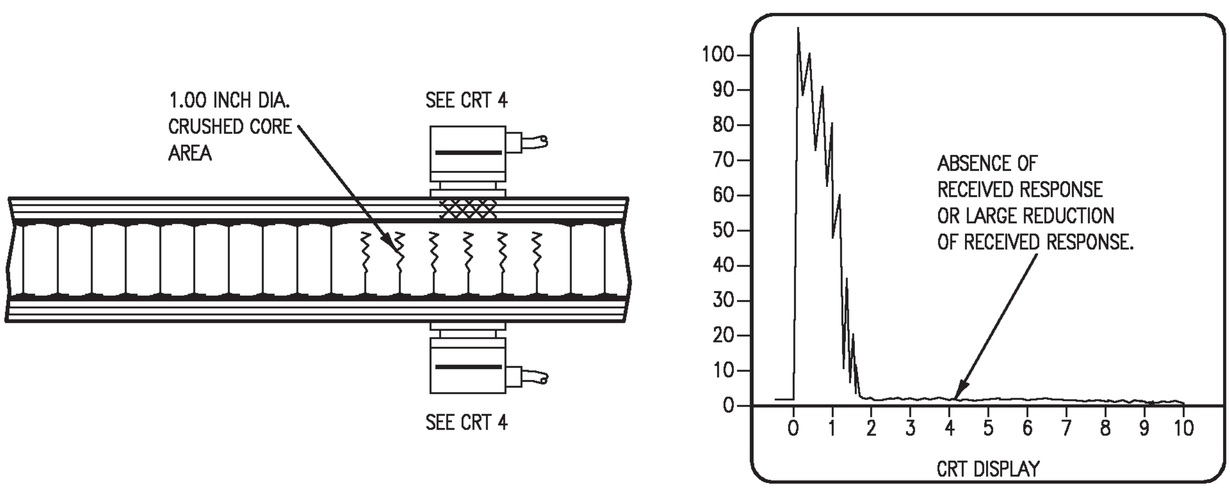


Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 1)



CRT 3



CRT 4

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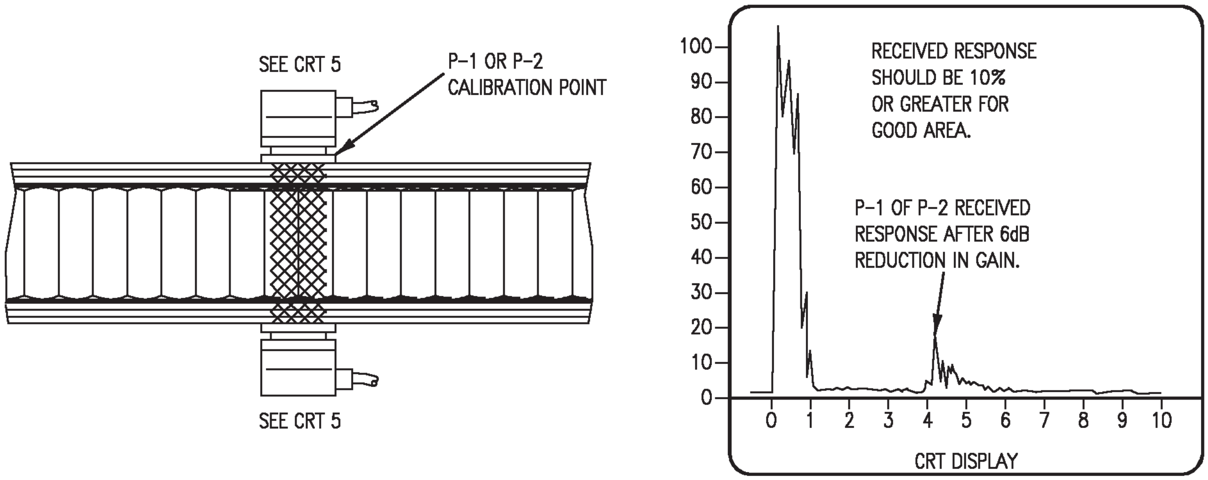
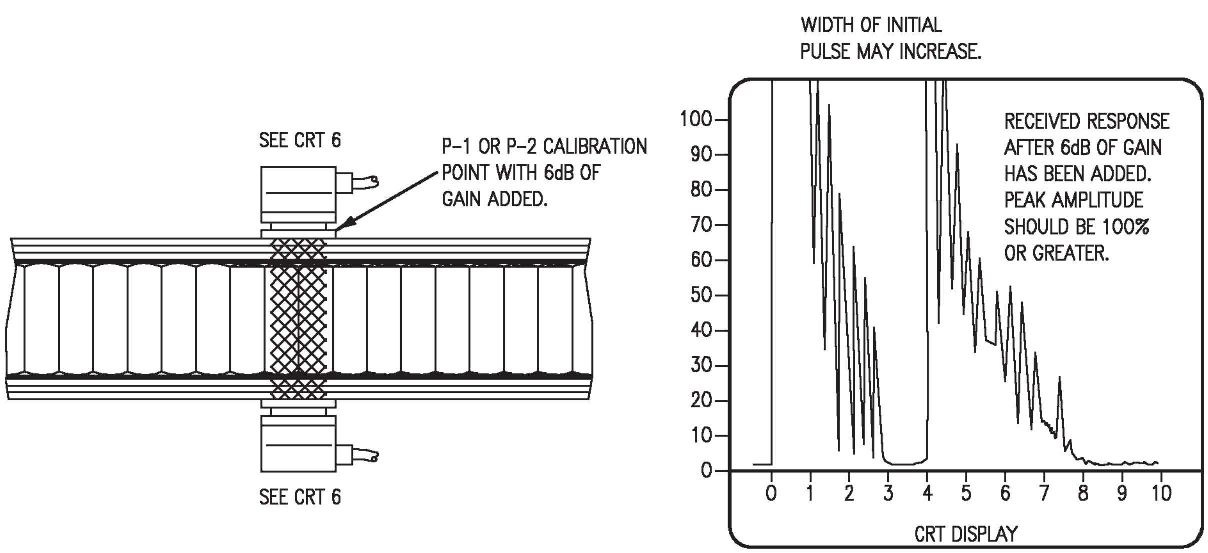
18AC-SRM-30-(38-2)34-SCAN

Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 2)



CRT 5



CRT 6

LEADING EDGE OF RECEIVED RESPONSE
SHOULD STILL BE LOCATED AT 4.

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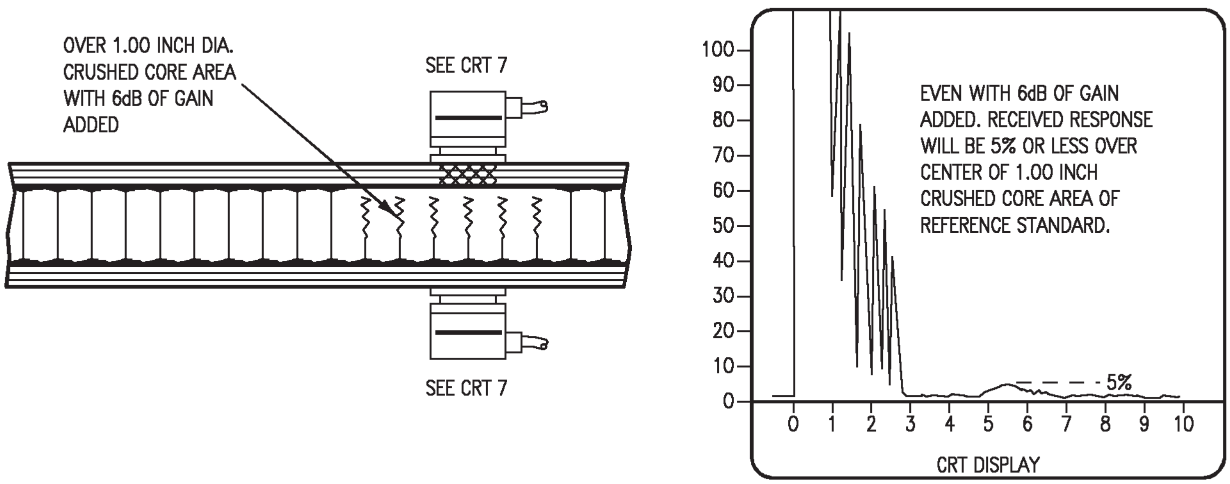
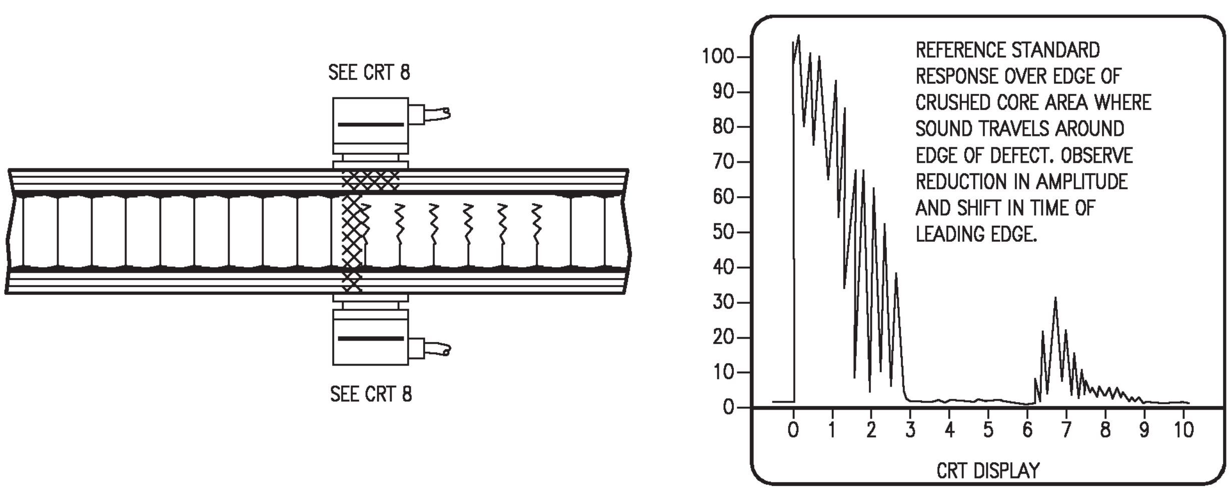
Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 3)



CRT 7



CRT 8

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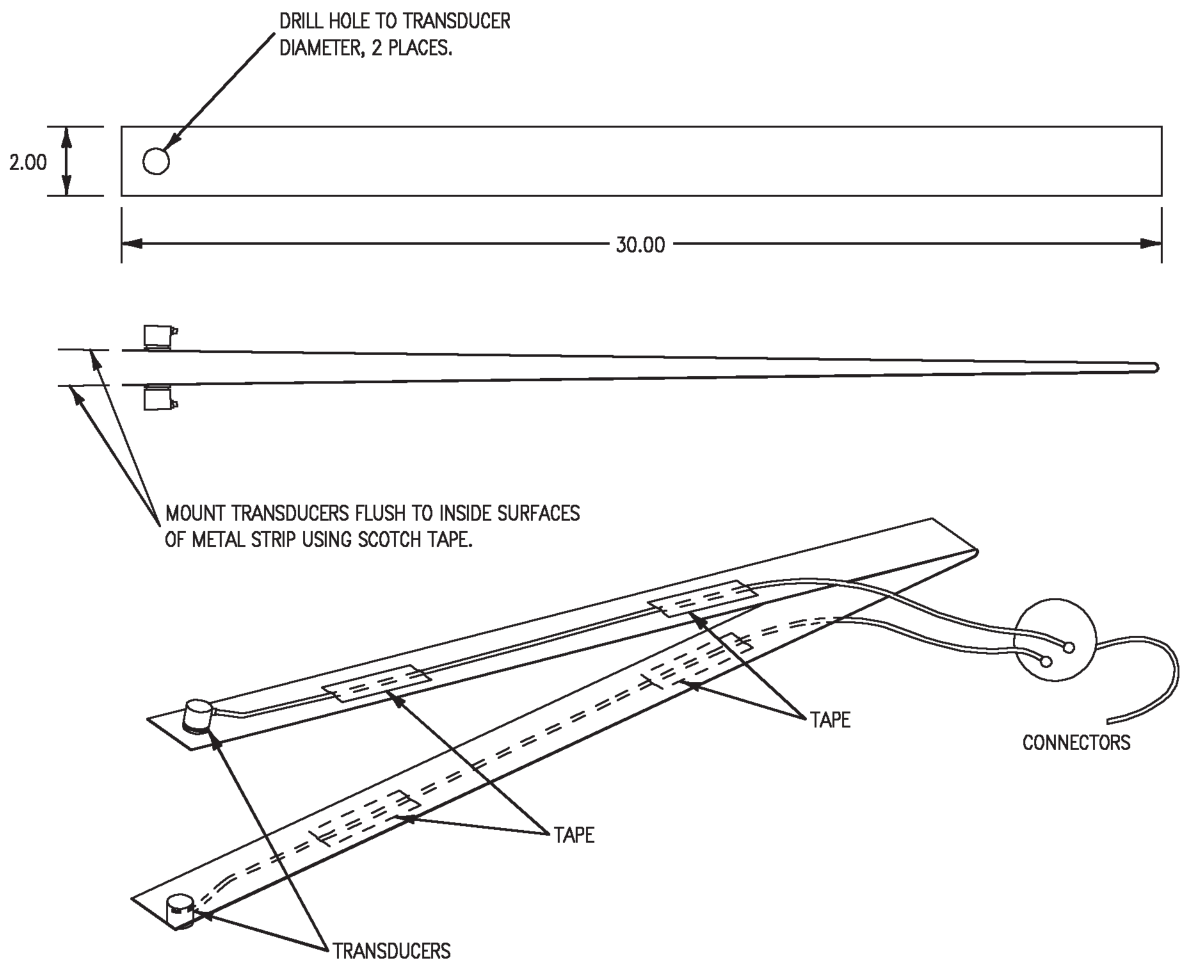
Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 4)



LEGEND

1. ANY 1/32-INCH OR LESS ALUMINUM MATERIAL.
2. HAND FORMED BEND RADIUS OF 1/4-INCH, APPROX.
3. THIS IS A HAND FORMED ALIGNMENT DEVICE USED ONLY TO COAXIALLY ALIGN TRANSDUCERS, SEARCH UNITS.

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18AC-SRM-30-(39-1)34-CATI

Figure 3.Typical Search Unit Alignment Device

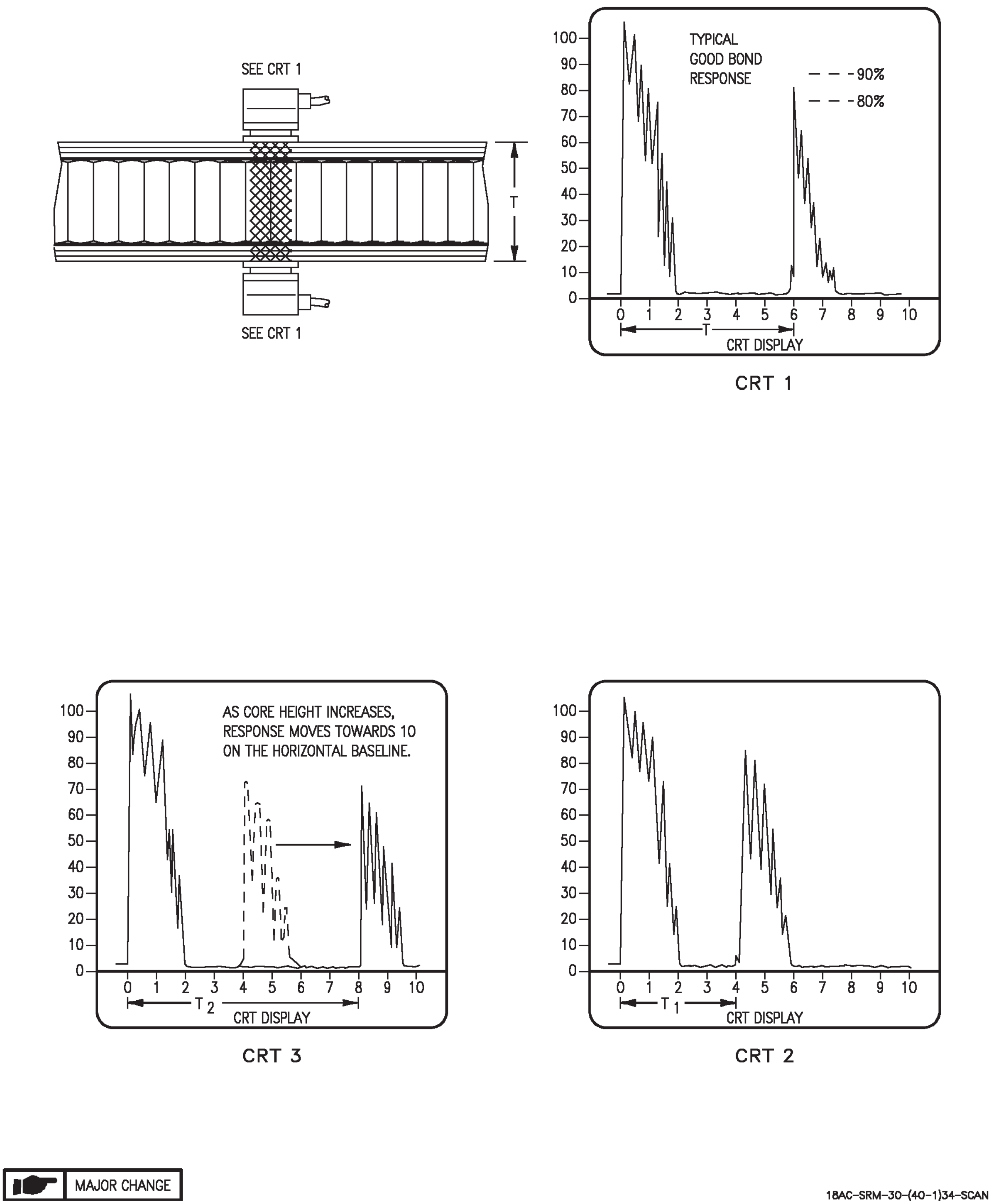

Figure 4. Typical Inspection Responses on Honeycomb Core Sandwich Assemblies (Sheet 1)

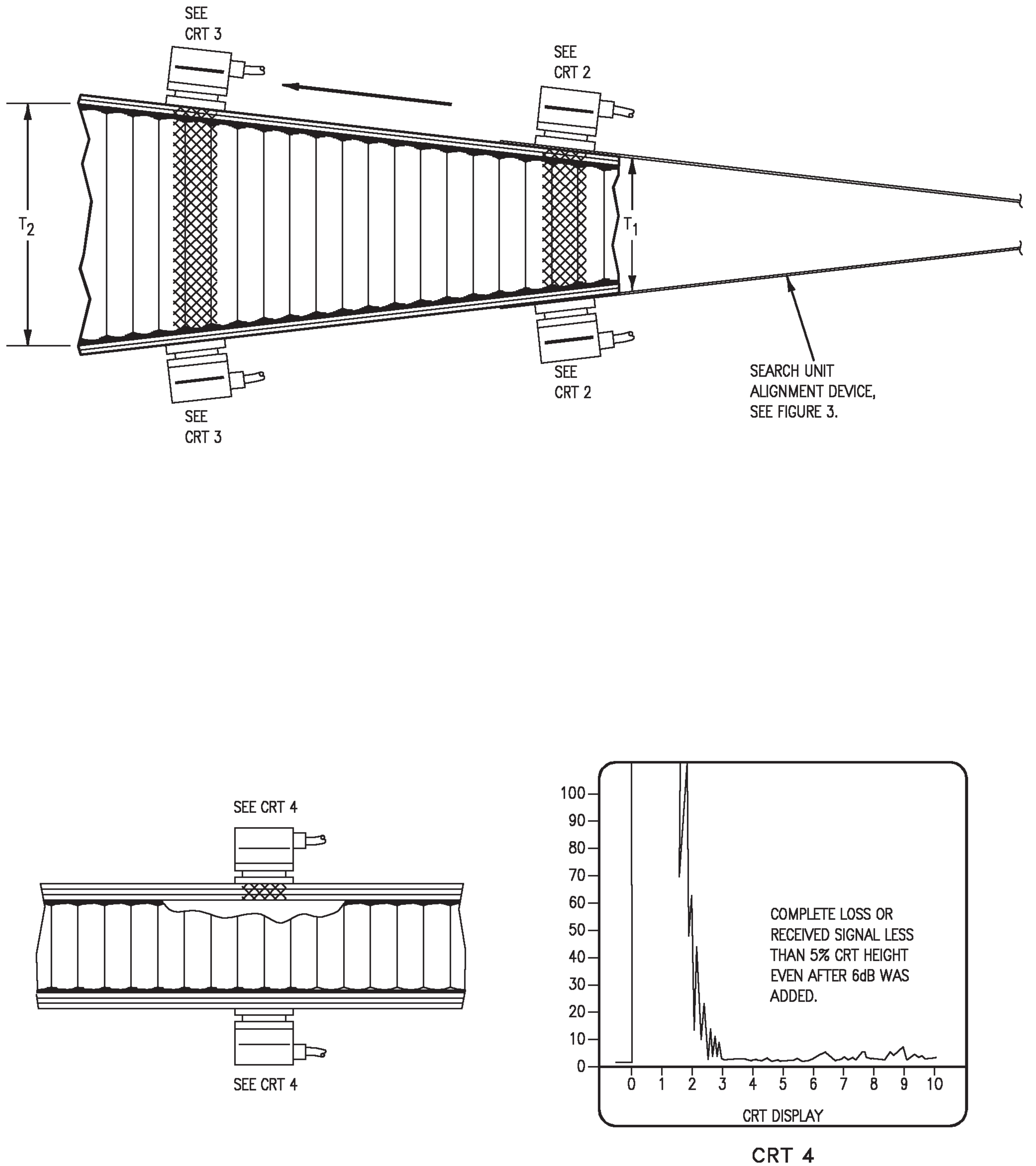

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Figure 4. Typical Inspection Responses on Honeycomb Core Sandwich Assemblies (Sheet 2)

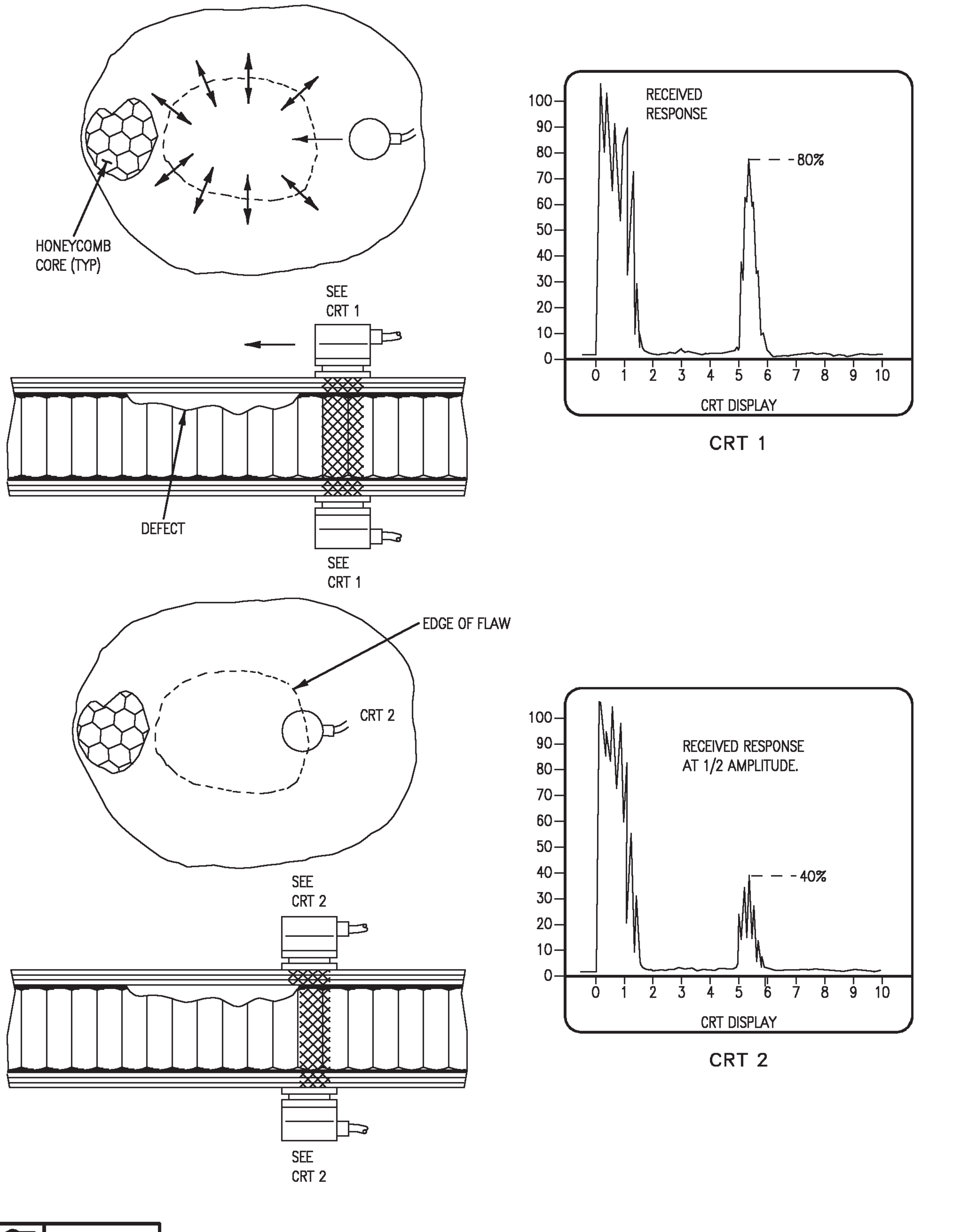

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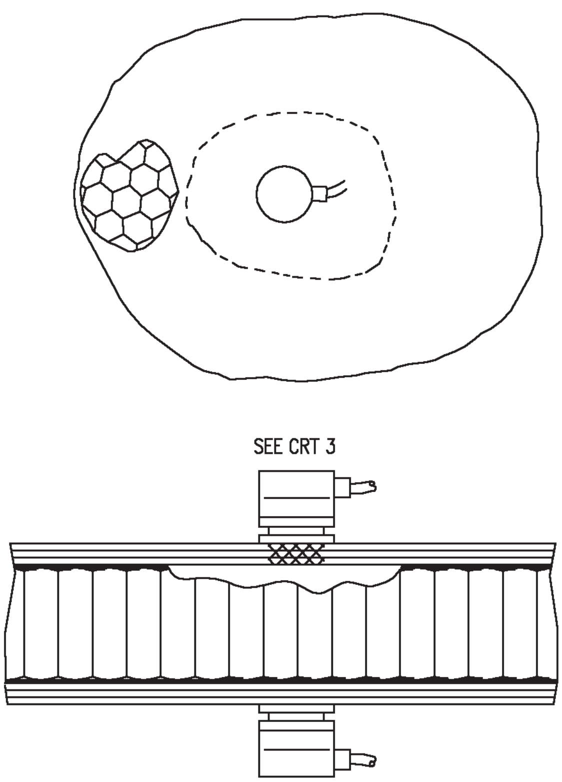
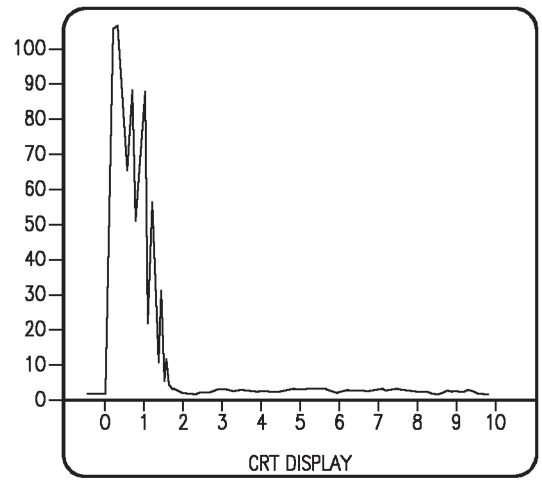
Figure 5. Half Amplitude Mapping (Sheet 1)





CRT 3

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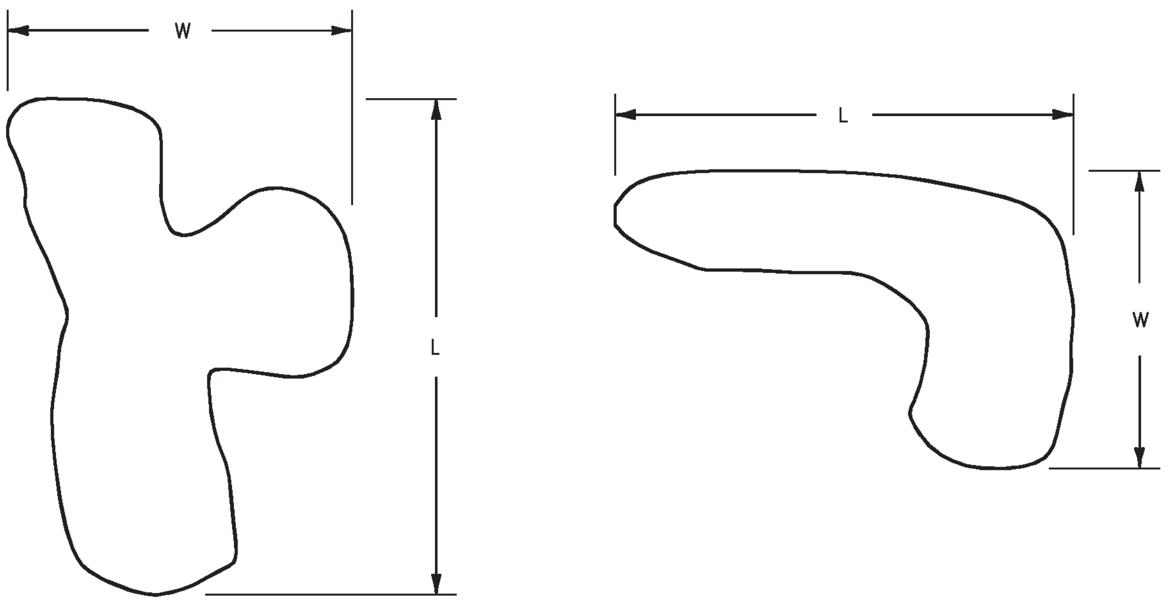
18AC-SRM-30-(41-2)34-SCAN

Figure 5. Half Amplitude Mapping (Sheet 2)



UNBOND
CURVE

L=LENGTH

W=WIDTH

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Figure 5. Half Amplitude Mapping (Sheet 3)

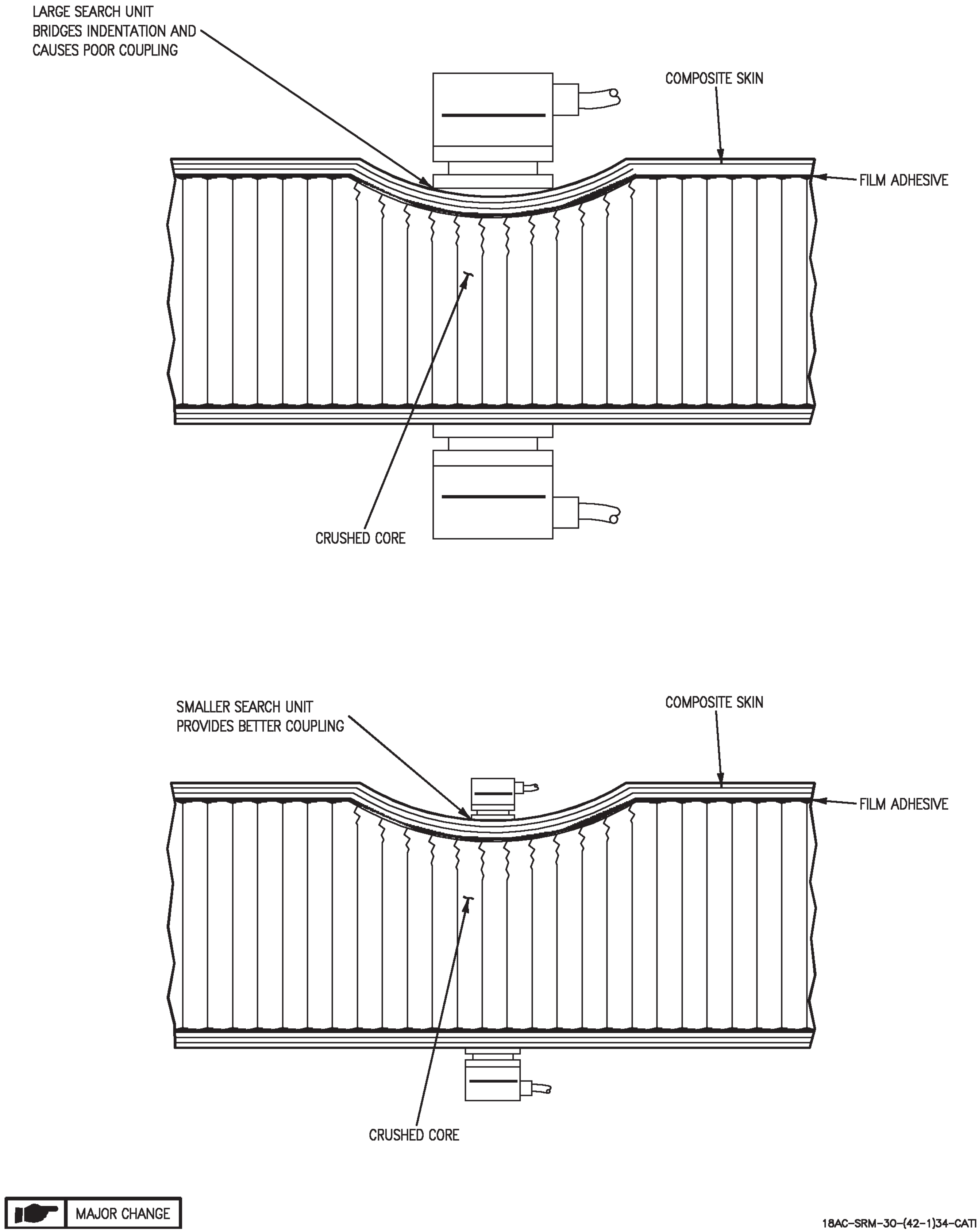


Figure 6. Typical Inspection on Honeycomb Core Sandwich Assemblies

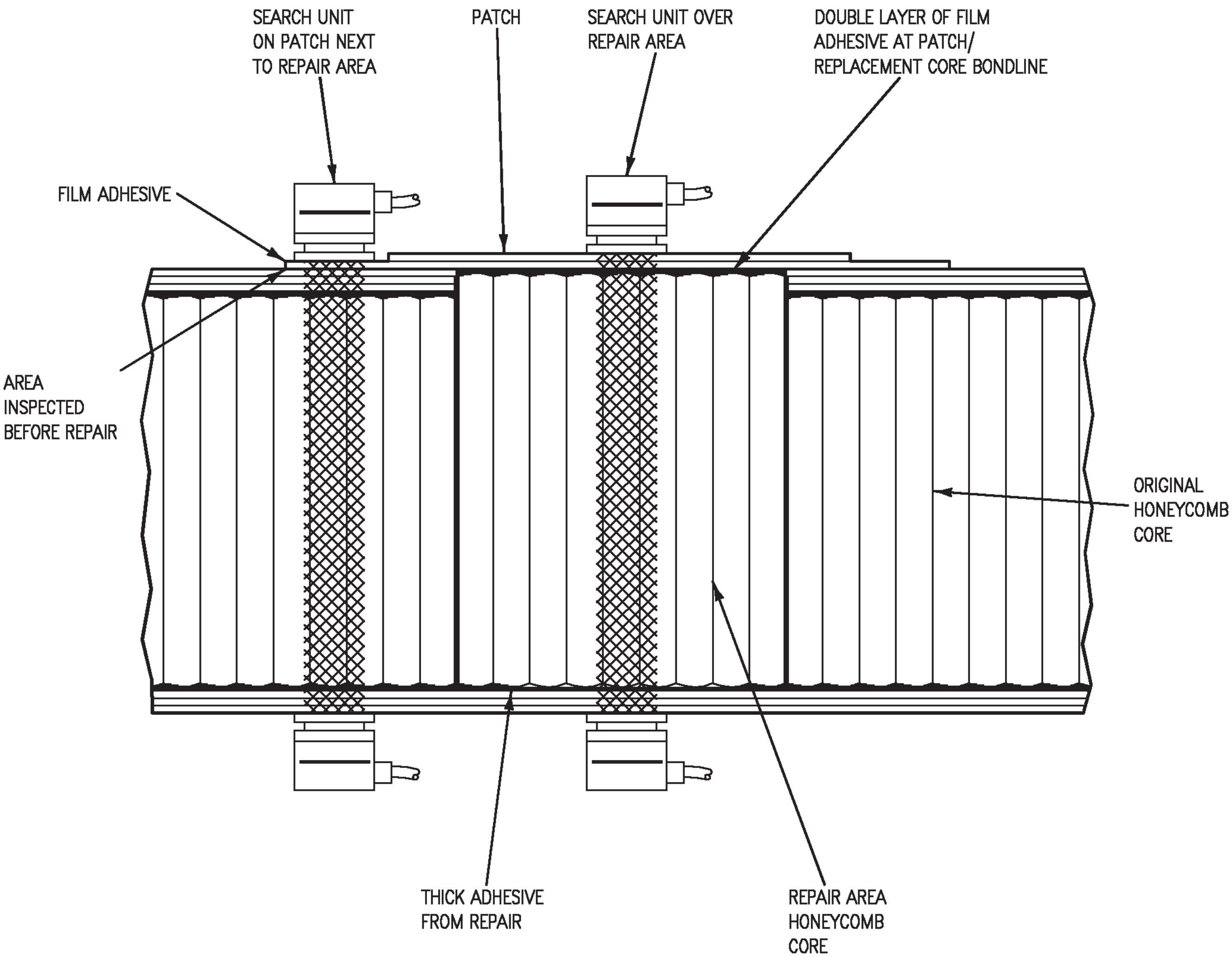
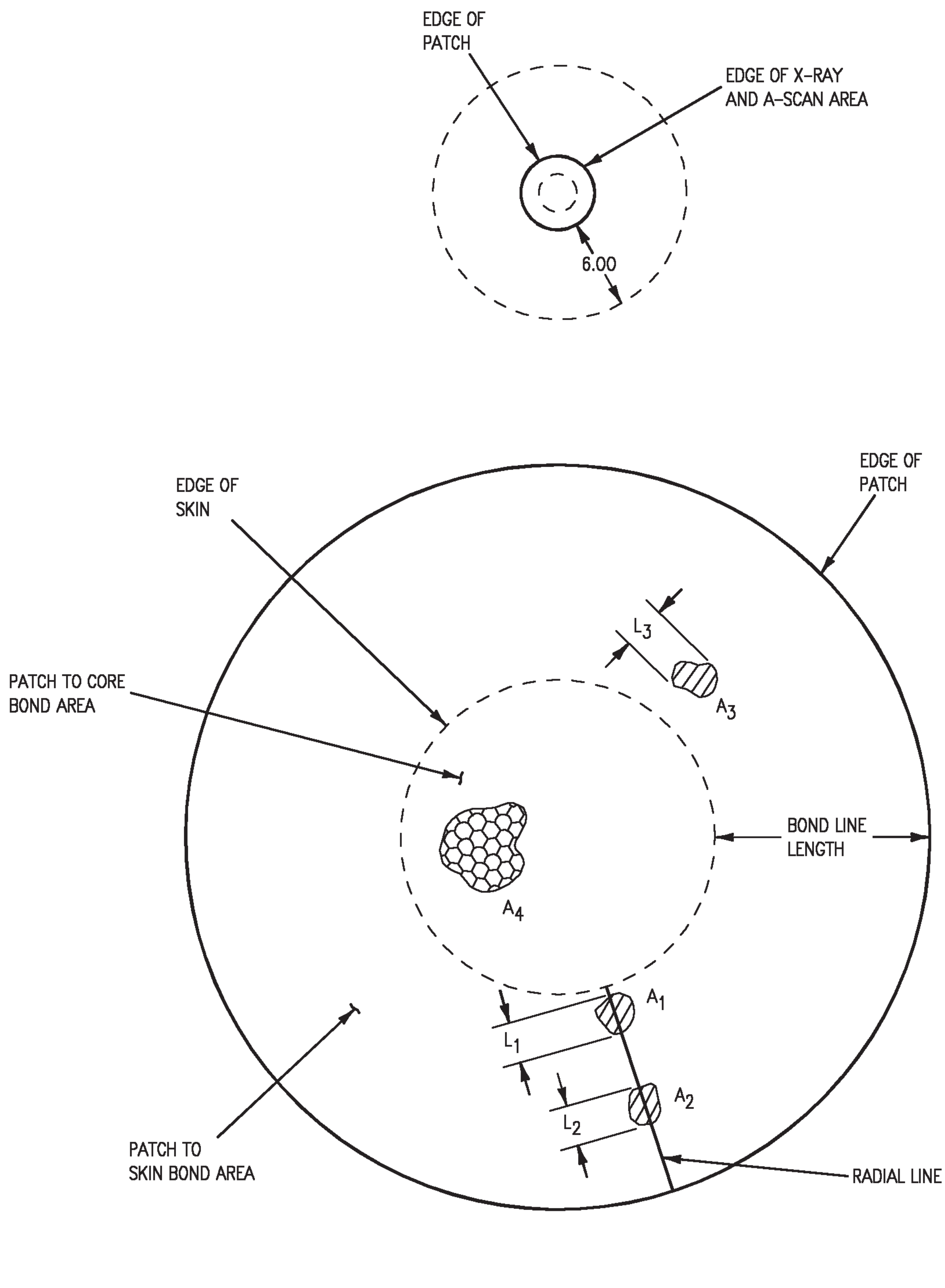


Figure 7. Setup for Typical Repair Evaluation



LEGEND

1. L = LENGTH
2. A = AREA
3. ACCEPTABLE FLAW LIMITS:
   A. $L_1 + L_2$ 0.31 OR LESS AND L_3 0.31 OR LESS
   B. $A_1 + A_2 + A_3$ 20% OR LESS PATCH TO SKIN BOND AREA
   C. A_4 WITHIN SKIN TO CORE UNBOND LIMITS OF SPECIFIC PROCEDURE WORK PACKAGE

18AC-SRM-30-(48-1)-SCAN

Figure 8. Typical Repair Evaluation

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO, LONGITUDINAL WAVE CONTACT, WITHOUT DELAY LINE, FOR COMPOSITE LAMINATE MATERIAL

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection	A1-F18AC-SRM-300
Pulse-Echo Longitudinal, Contact Thickness Inspection of Metallic Materials and Composite Laminates	WP008 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed, longitudinal, ultrasonic waves are used to inspect composite laminate materials. In pulse-echo mode, a single search unit, or transducer, is used to both send and receive ultrasonic energy. The search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is then used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on a cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical (static) grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical

systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI TECHNICIANS, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable two Reqd
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cable.

b. Connect BNC end of connecting cable to T or R BNC jacks on ultrasonic flaw detector (tester).

c. Turn tester ON, allow 15 minutes warm-up.

d. Set tester front face settings;

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COURSE SWEEP RANGE, FREQ, FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. If required, use alternate settings to produce optimum setup.

COARSE SWEEP RANGE	1.0 INCHES
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0 - 3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE-ECHO
FINE GAIN	MID SCALE
COARSE GAIN	APPROX 1
REP RATE	AUTO
FINE SWEEP RANGE	MIN
DAMPING	MID SCALE
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water or cloth moistened with cleaning compound, as required, to make sure inspection area(s) is free of contamination or foreign material.

f. With search units held in the air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

6. **TIME-BASE STANDARDIZATION.**

7. **Composite Laminates Up to 0.450 Inch Thick.** Time base standardization is required because delaminations in composite materials are detected ultrasonically as changes in material thickness. For composite materials up to 0.450 thick, use 74D111295-1009 FBH reference standard, which is part of 74D110175-1001 reference standard set, to complete following time base standardization sequence. This sequence of steps will set tester so one large division on horizontal baseline of CRT will represent 0.050 of material. Depth of unknown responses can be calculated after this standardization is complete.

Unknown Response = Depth (Thickness)	CRT Large Division X 0.050 inch per CRT Large Division

NOTE

Flat bottom holes are machined into FBH reference standards to create known depths or thicknesses of material. Number listed before abbreviation, FBH, in text that follows, represents material thickness or depth of material above ultrasonic reflecting surface of flat bottom hole. Thicknesses may vary from standard to standard. Reference standard used should be of same materials as part(s) being inspected.

a. Begin with front face settings as described in paragraph 5.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to upper surface of composite laminate FBH reference standard, over 0.400, see figure 1, FBH.

c. Position search unit over 0.400 FBH.

d. Adjust FINE SWEEP DELAY and RANGE until back surface response from 0.400 FBH is visible on the CRT.

e. Adjust GAIN so peak amplitude of first back surface response from 0.400 FBH is 80 to 90 percent CRT height. See Figure 2, CRT 1.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. Damp bottom, or reflecting surface, of FBH to make sure correct response if being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Assuming there are no flaws between front surface of reference standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

REJECT greater than 30 percent is not recommended.

g. Use DAMP. and REJECT to optimize response and minimize baseline noise. Remove couplant from reflecting surface of FBH before continuing.

h. With peak amplitude of 0.400 FBH first back surface response at 80 to 90 percent CRT height, adjust FINE SWEEP RANGE to locate leading edge of 0.400 FBH back surface response at 8 on CRT horizontal baseline. See figure 2, CRT 2.

i. Apply couplant to upper surface of composite laminate reference standard above 0.100 FBH.

j. Position search unit over 0.100 FBH.

k. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 2, CRT 3.

l. Damp bottom, or reflecting surface, of FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

m. Remove couplant from reflecting surface before continuing.

NOTE

Make sure trailing edge of initial pulse is located at less than one large division on CRT horizontal baseline when 0.100 FBH first back surface response is 80 to 90 percent CRT height. See figure 2, CRT 4.

n. With peak amplitude of 0.100 FBH first back surface response at 80 to 90 percent CRT height, adjust FINE SWEEP RANGE to locate leading edge of 0.100 FBH back surface response at 2 on CRT horizontal baseline. See figure 2, CRT 4.

o. Reposition search unit over 0.400 FBH and verify leading edge of 0.400 FBH back surface response is still located at 8 on horizontal baseline of CRT when peak amplitude of 0.400 FBH response is 80 to 90 percent CRT height. See figure 2, CRT 5, If not, adjust FINE SWEEP RANGE to relocate 0.400 FBH response leading edge to 8.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates up to 0.450 in thickness. CRT horizontal baseline is set so each of ten large horizontal baseline divisions represents 0.050 of material. See figure 2, CRT 6.

p. If change was required to relocate 0.400 FBH response leading edge to 8 on horizontal baseline of CRT, reposition search unit over 0.100 FBH to verify leading edge of 0.100 FBH response is still located at 2 on CRT horizontal baseline when peak amplitude of 0.100 FBH response is 80 to 90 percent CRT height. See figure 2, CRT 6. Make sure trailing edge of initial pulse is still less than 1, if not, repeat steps n. and o. as many times as required.

q. Test setup by positioning search unit over another FBH, depth of which is accurately known. FBH response leading edge location, when peak amplitude is 80 to 90 percent CRT height, should be as follows:

$$\text{CRT Large Division Response Location} = \frac{\text{FBH Depth (Inch)}}{\text{0.050 Inch per CRT Large Division}}$$

8. **Composite Laminates Up to 0.950 Inch Thick.** Time base standardization is required because delaminations in composite materials are detected

ultrasonically as changes in material thickness. For composite materials up to 0.950 use 74D111295-1007 FBH reference standard, which is part of the 74D110175-1001 reference standard set, to complete following time base standardization sequence. This sequence of steps will set tester such that one large division on horizontal baseline of CRT will represent 0.100 of material. Depth of unknown responses can be calculated after this standardization is complete:

Unknown Response = Depth (Thickness)	CRT Large Division X 0.100 Inch per CRT Large Division

NOTE

For composite laminates up to 0.950, some 5 MHz transducers may be inadequate. A 2.25 MHz transducer may be used if 5 MHz is not enough.

a. Begin with tester front face settings as described in paragraph 5.

b. Change COARSE SWEEP RANGE to 2.0 before beginning.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to upper surface of composite laminate reference standard, over 0.800 FBH. See figure 3.

d. Position search unit over 0.800 FBH.

e. Adjust GAIN, FINE SWEEP DELAY, and RANGE until back surface response from 0.800 FBH is visible on CRT.

f. Adjust GAIN so peak amplitude of first back surface response from 0.800 FBH is 80 to 90 percent CRT height. See figure 4, CRT 1.

NOTE

Assuming there are no flaws between front surface of reference standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. A change in response signal during damping indicates correct response is being received and displayed on CRT.

g. Damp bottom, or reflecting surface, of 0.800 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

h. Use DAMP. and REJECT to optimize response and minimize baseline noise. Remove couplant from reflecting surface of FBH before continuing.

i. With amplitude of first 0.800 FBH back surface response at 80 to 90 percent CRT height, use FINE SWEEP DELAY and RANGE to locate leading edge of 0.800 FBH at 8 on CRT horizontal baseline. See figure 4, CRT 2.

j. Apply couplant to upper surface of composite laminate reference standard above 0.400 FBH.

k. Position search unit over 0.400 FBH.

l. Adjust GAIN so peak amplitude of first back reflection from 0.400 FBH is 80 to 90 percent CRT height. See figure 4, CRT 3.

m. Damp bottom, or reflecting surface, of FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

n. Remove couplant from reflecting surface before continuing.

o. With peak amplitude of 0.400 FBH first back response at 80 to 90 percent CRT height, use FINE SWEEP DELAY locate leading edge of 0.400 FBH back surface response at 4 on CRT horizontal baseline. See figure 4, CRT 4.

p. Reposition search unit over 0.800 FBH and verify leading edge of 0.800 FBH first back surface response is still located at 8 on CRT horizontal baseline. See figure 4, CRT 5. If not, use FINE SWEEP RANGE to relocate 0.800 FBH response leading edge to 8.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates up to 0.950 in thickness. CRT horizontal baseline is set so each of 10 large horizontal baseline divisions represents 0.100 of material. See figure 4, CRT 6.

q. If changes were required to relocate 0.800 FBH response leading edge to 8 on CRT horizontal baseline, reposition search unit over 0.400 FBH to verify leading edge of 0.100 FBH response is still located at 4 on CRT horizontal baseline. If not, repeat steps o. and q. as many times as required.

r. Test setup by positioning search unit over another FBH, depth of which is accurately known. FBH response leading edge, when peak amplitudes is 80 to 90 percent CRT height, should be as follows:

$$\text{CRT Large Division Response Location} = \frac{\text{FBH Depth (Inch)}}{\text{0.100 Inch per CRT Large Division}}$$

NOTE

Before beginning inspection, use 74D111295-1009 FBH reference standard to make sure trailing edge of initial pulse is located at less than one large division on CRT horizontal baseline when 0.100 FBH first back surface response is 80 to 90 percent CRT height.

9. INSPECTION PROCEDURES.

10. Inspection of Solid Laminates.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination of foreign.

b. Before beginning inspection, determine locations of ply changes, rabbets, stiffeners, and other items lying beneath surface of area to be inspected. This information should be described in specific procedure work packages. Lay out locations of ply changes, rabbets, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar overlay. Also include applicable thicknesses of part or areas of part on overlay.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

c. To make sure large parts are completely inspected, mark grid pattern on inspection area per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 inch grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5 and 6 for composite thickness of part being inspected.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit wear face should be parallel to back surface of laminate. See figure 5, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 5, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 of search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 7. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid block.

i. Use guidelines given in paragraph 12 on CRT interpretation to identify flaws.

j. Once flaw has been identified, use pulse-echo mapping technique shown in figure 8 and described in paragraph 23.a. for 1/2 amplitude mapping, and figure 9, paragraph 23. b. for mapping flaws close to surface or small multiple delaminations to determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge or by using delay line technique when defect is closer to surface.

k. Mark all flaw indications on part surface with aircraft marking pencil.

11. **Edge Repair Inspection.**

a. Determine laminate thickness in repaired area and area to repair.

b. Mark original damage outline on part surface with aircraft marking pencil as shown in figure 6.

c. Standardize tester per paragraphs 5 and 6 for composite thickness range used in evaluating original damage.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

d. Apply couplant to repaired area and surrounding good area, usually 1.00 beyond original flaw outline.

e. Position search unit on nearby non flawed area. Adjust GAIN to locate back surface at 80 to 90 percent CRT height. See figure 6, CRT 1. If possible, finger damp back surface to make sure correct response is being received and viewed on CRT.

f. Move search unit from nearby non-flaw area to repaired area, monitoring back surface response leading edge location on horizontal baseline and back surface response peak amplitude. Refer to paragraph 18 for CRT interpretation/flaw identification guidelines.

g. Mark areas with aircraft marking pencil, where back surface response disappears.

h. After marking preliminary flaw outline, use applicable amplitude mapping technique shown in figures 11 and 12 and described in paragraphs 23.a. and 23.b. to determine edge of remaining defect.

i. Mark flaw indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

12. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, back surface response, and possibly back surface response multiples should be visible on CRT. Back surface response should be located at

CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 5, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed before inspection, described in paragraph 6.

13. **Single Level Delamination.** Delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 5, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 5, CRT 3.

14. **Small Delaminations/Porosity and Large Near Surface Delaminations.** Small delamination/porosity throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 5, CRT 4.

NOTE

If not clear whether indication is due to near surface delamination or presence of heavy porosity, and back surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates delamination is present. If small response is detected, it is likely area contains heavy porosity.

15. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate response may be due to presence of numerous planar voids and multiples from single planar voids. See figure 5, CRT 5.

16. **Multiple Level Delaminations.** Appearance of more than one intermediate response and absence of back surface response may indicate multiple level delamination. Example is shown in figure 5, CRT 6. Depending on depth of each delamaination level, multiples from various levels may also appear. See figure 5, CRT 7.

NOTE

Too much gain may result in sensitivity level where meaningless responses will appear. Increasing gain may produce intermediate response multiples.

17. **Tapers.** Tapers should be described in specific work package or in specific structure repair work packages (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area. When search unit is placed over area outside of taper, where front and back surfaces of part are parallel, back surface response will appear at CRT horizontal baseline corresponding to part thickness at that point. GAIN should be adjusted to back surface response at such point is 80 to 90 percent CRT height. See figure 5, CRT 8. As search unit is moved across area of taper in which thickness of part is increasing, back surface response will decrease in amplitude and move away from initial pulse. See figure 5, CRT 9. As search unit is moved across an area of taper in which thickness of part is decreasing, back surfaces response will increase in amplitude and move toward initial pulse. If back surface amplitude is significantly decreased due to added thickness on taper, increase gain so back surface response is back up to 80 to 90 percent CRT height. See figure 5, CRT 10. Depending on new part thickness when taper ends, gain may need to be adjusted again so back surface response is 80 to 90 percent CRT height. See figure 5, CRT 11. Intermediate responses may appear when gain is increased.

18. **Edge Repair.** Adhesive filled edge repair area will result in intermediate response from repair area and reduction in back surface amplitude due to attenuation from repair area. See figure 5, CRT 12. Repair area containing adhesive void will be indicated by intermediate response and absence of back surface response. Increase in amplitude of intermediate response compared flaw free repair area response is likely, but may not always occur. See figure 5, CRT 13.

NOTE

When inspecting areas containing liquid shim, it may be required to increase gain to peak back surface response. Intermediate responses may occur when gain is increased.

19. **Liquid Shim.** When search unit is placed over laminate containing liquid shim between skin and substructure, several responses are possible. When search unit is placed over sealant groove, back surface amplitude may be reduced since energy is coupled into liquid shim and channel sealant. See figure 5, CRT 14. In other areas, where there is liquid shim between laminate and substructure, back surface response may be decreased in amplitude, since some energy is coupled into shim and substructure. Reflections from shim/substructure and substructure/air interfaces may appear. See figure 5, CRT 15. Rather than appearing as distinct responses to left of back surface response, back surface response will be broadened and decreased in amplitude due to reflections from shim/substructure and substructure interfaces.

20. **Abrupt Thickness Change.** Locations of abrupt thickness changes should be noted in specific work packages or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750). When search unit is placed over area containing thickness change, back surface response from each thickness will appear. Amplitude of each response will be reduced compared to signal from single thickness area. See figure 5, CRT 16.

21. **Cocured Composite Stiffener.** As search unit is moved across area containing cocured composite stiffener, variety of responses will occur. Example is shown in figure 5, CRTs 17 through 20. Before search unit is placed over underlying stiffener, there should be back surface response, its amplitude between 80 and 90 percent height located at CRT horizontal baseline representing its thickness, T1. See figure 5, CRT 17. Moving search unit across laminate surface so it covers part of underlying composite flange, back surface response will decrease in amplitude as flange response appears. With half of search unit covering flange, both back surface and flange responses will have decreased amplitudes compared to original back surface response. Flange response will be located at CRT horizontal baseline location representing T2, sum of laminate and flange thicknesses. See figure 5, CRT 18. Depending on laminate and flange thicknesses, as well as tester settings, laminate and flange responses may not be distinct so only one broadened response with reduced amplitude appears. When search unit is moved completely over flange, back surface response may completely disappear so only flange response appears. Flange response should have increased amplitude compared to responses when half of search unit covered flange, and should be located at CRT horizontal baseline division representing T2. See figure 5, CRT 19. Depending on thicknesses and flaw detector settings, small back surface response may still be received. When search unit is placed directly over stiffener, response may completely disappear since ultrasonic energy is coupled into stiffener. See figure 5, CRT 20. If stiffener is unbonded from laminate back surface or if there are voids, back surface response will appear and will be located at CRT horizontal baseline division representing T1, laminate thickness. Amplitude of this response will depend on size of unbond, void, etc. at interface since defect size will determine amount of ultrasonic energy coupled into stiffener. Even if there are no defects at stiffener/back surface interface, small back surface response may be present at T1 location on CRT horizontal baseline.

22. **Excess Resin.** Responses may result from excess resin, or resin-rich areas, in laminates. Excess resin will cause intermediate response, combined with slight reduction in back surface response. See figure 5, CRT 21.

23. **MAPPING.**

a. Half amplitude Mapping.

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 8, CRT 1.

(3) Move search unit toward good areas in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude. See figure 8, CRTs 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping for Flaws Close to Surface or Small Multiple Delaminations.

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 9, CRT 1.

(3) Move search unit in toward flaw in all directions. Use Aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent of CRT height. See figure 9, CRTs 2 and 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 10.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

24. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part.

c. Determine depth of defects, when required by using equations in paragraphs 7 and 8. If more accurate measurements are required do depth measurement using thickness gauge in (WP008 08).

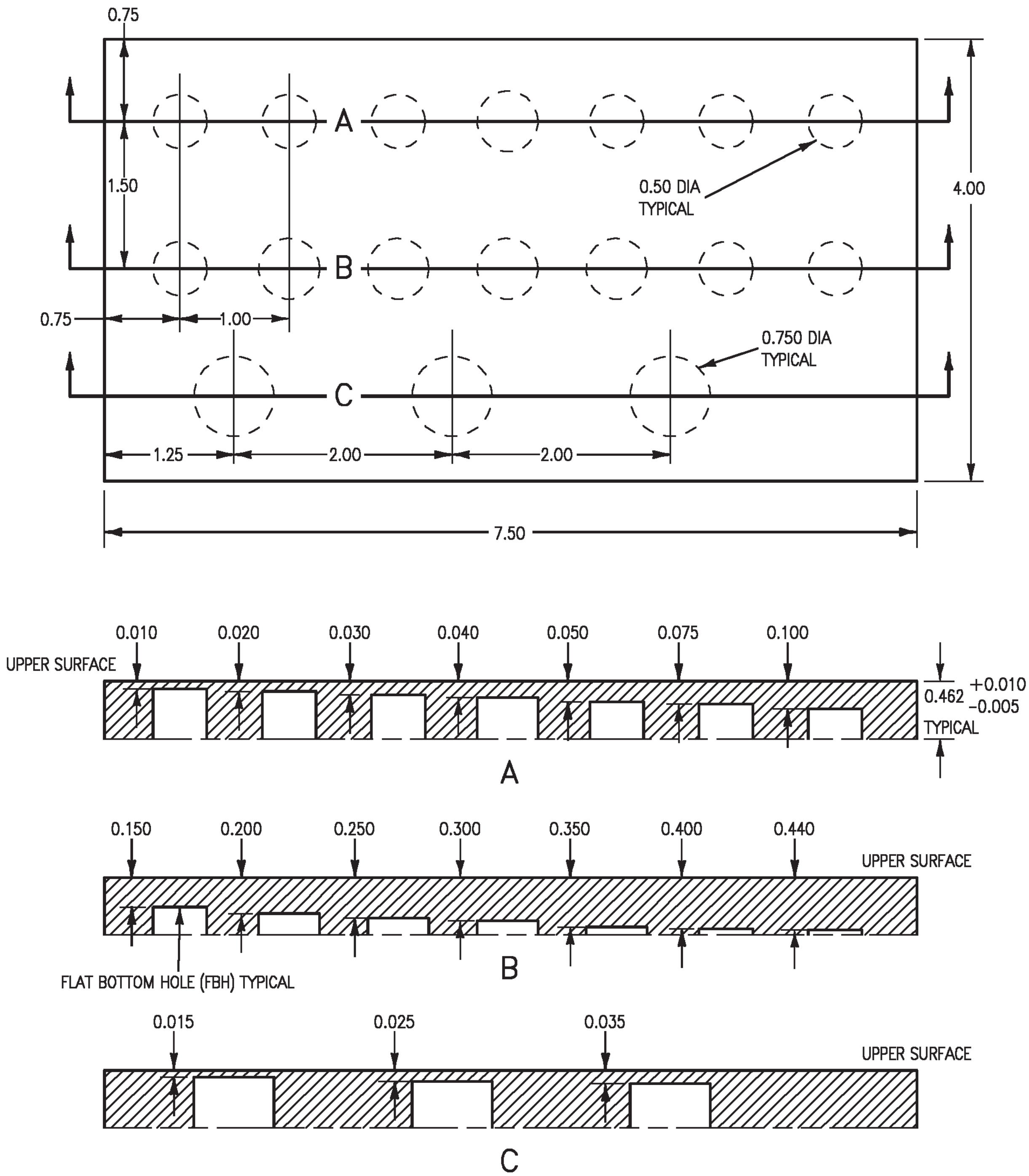
WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

25. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.



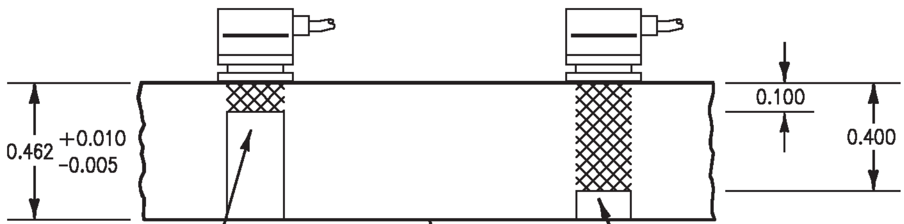
74D111295-1009

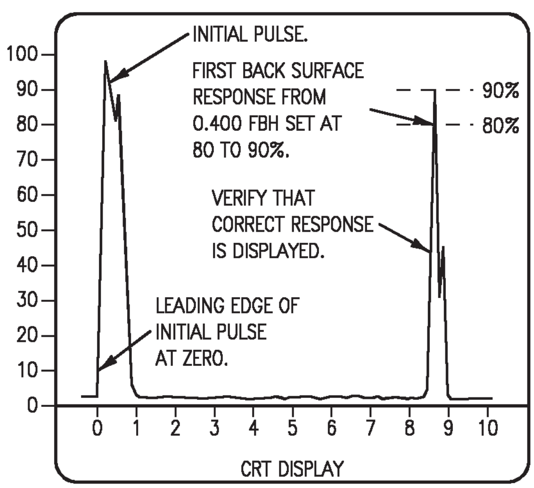
GRAPHITE EPOXY LAMINATE

FLAT BOTTOM HOLE ULTRASONIC REFERENCE
STANDARD FOR LAMINATES TO 0.450 INCH.
ALL THICKNESSES SHOWN ARE NOMINAL
AND MAY VARY FROM STANDARD TO STANDARD.

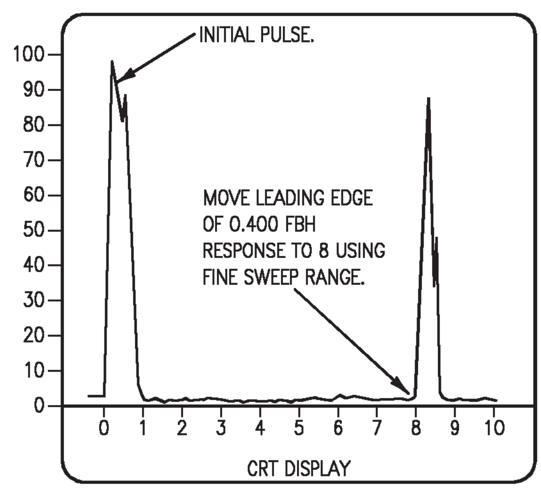
18AC-SRM-30-(51-1)-CATI

Figure 1. FBH Reference Standard For 0.450 Inch Setup





CRT 1

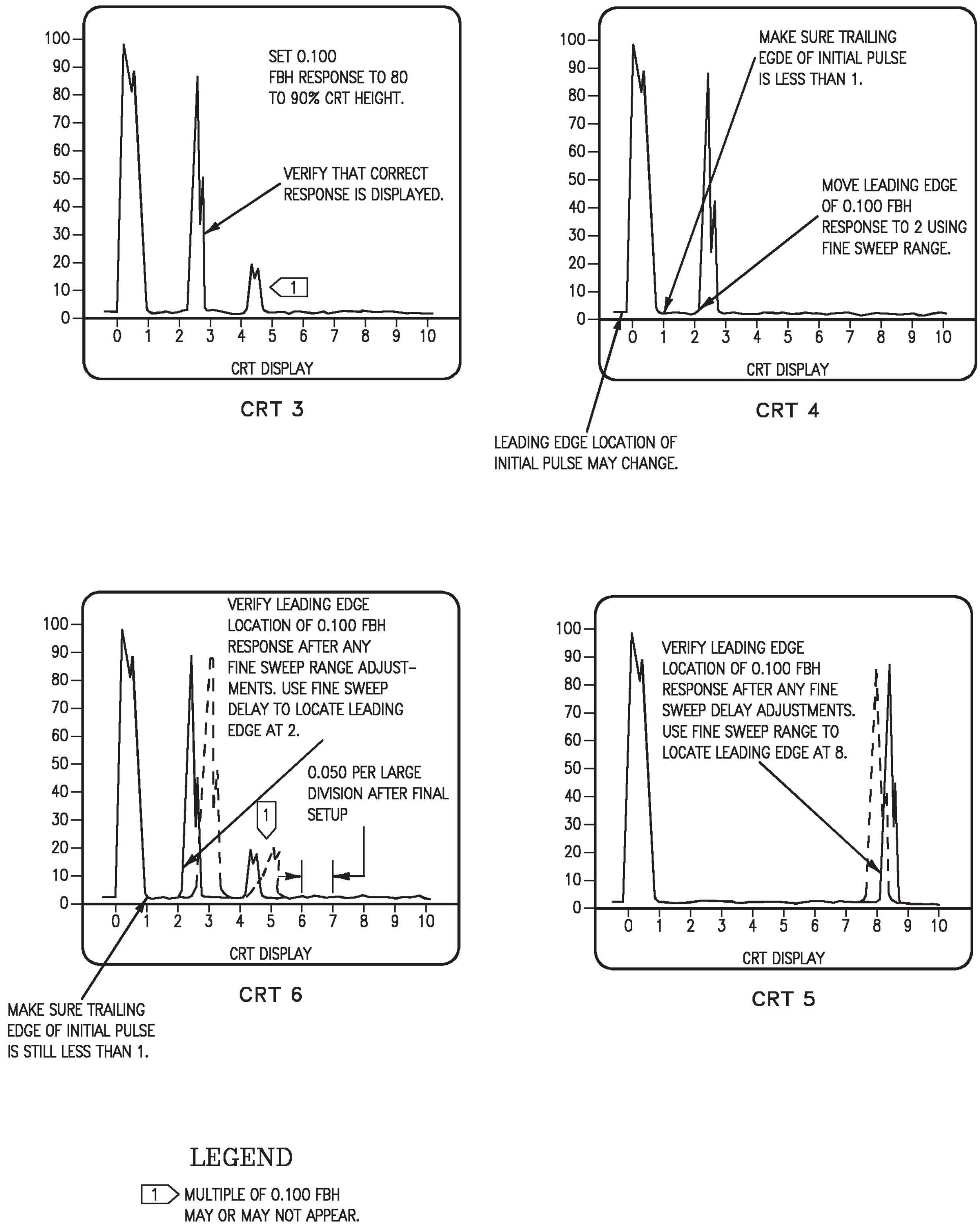


CRT 2

MAJOR CHANGE

18AC-SRM-30-(52-1)34-CATI

Figure 2. Setup For 0.450 Inch Composite (Sheet 1)



MAJOR CHANGE

18AC-SRM-30-(52-2)34-CATI

Figure 2. Setup for 0.450 Inch Composite (Sheet 2)

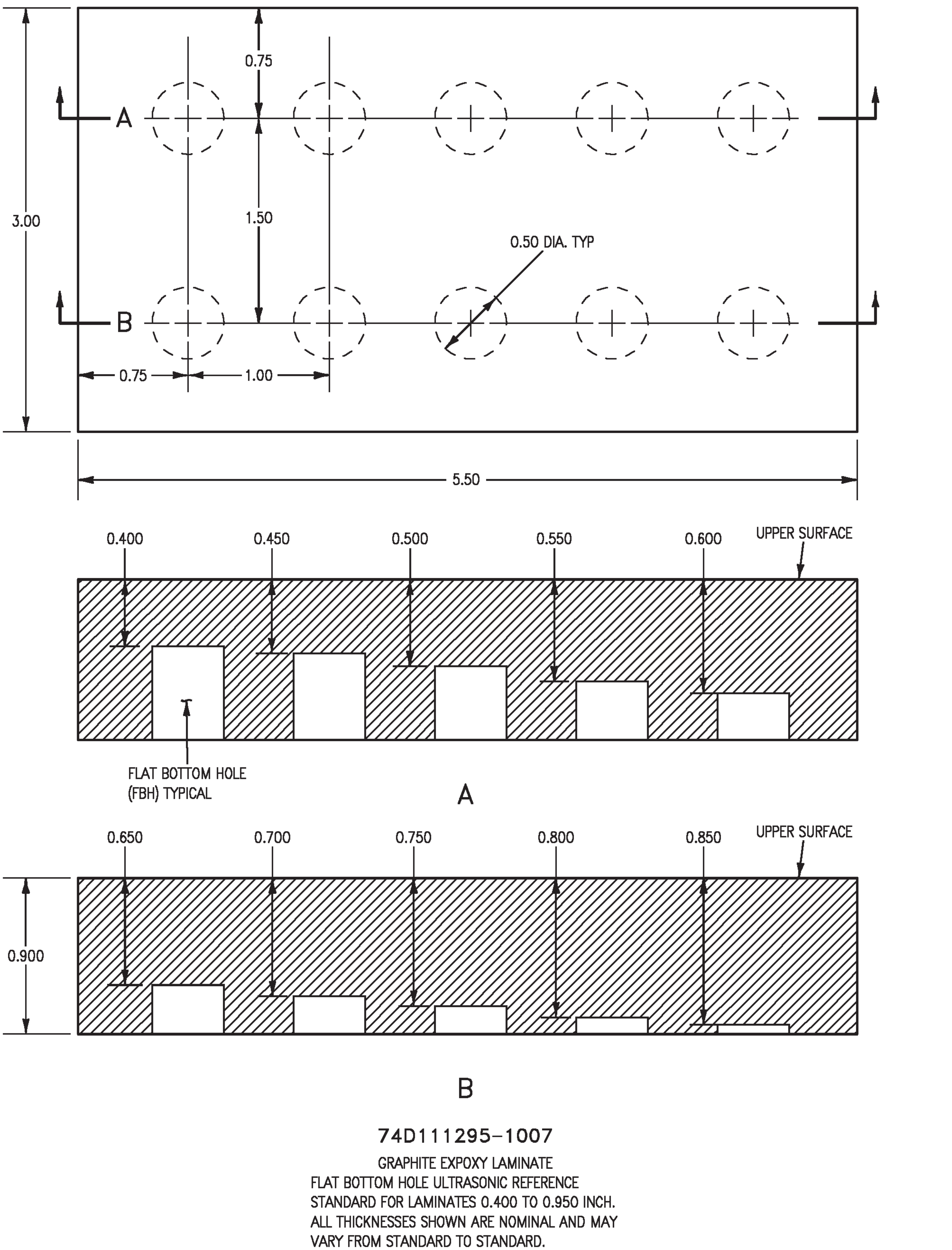
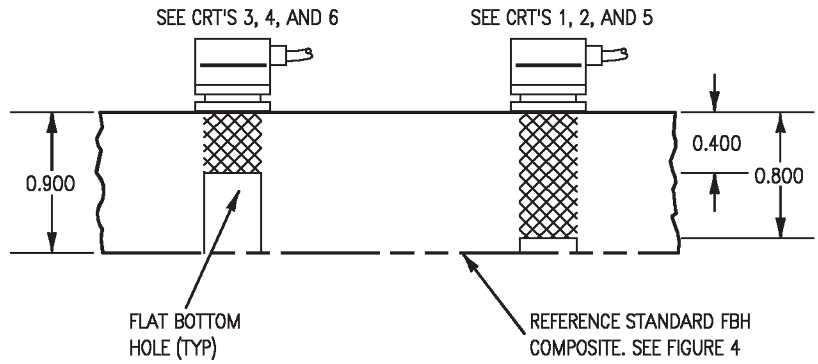
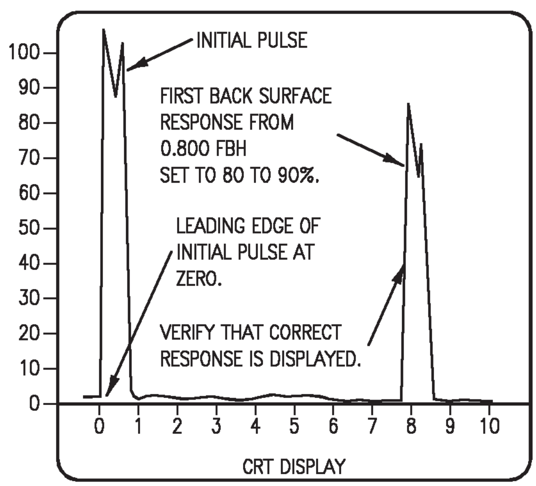
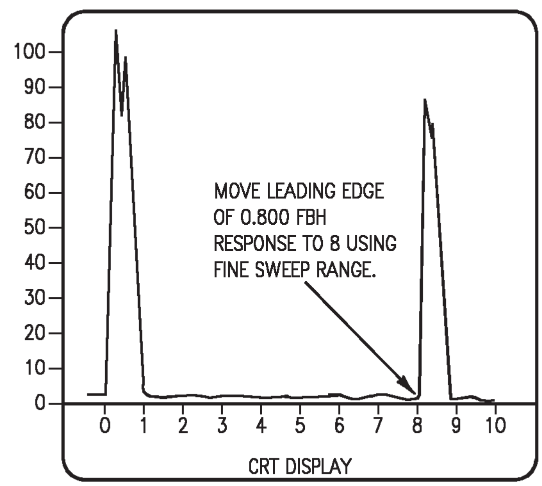


Figure 3. FBH Reference Standard For 0.950 Inch Setup





CRT 1

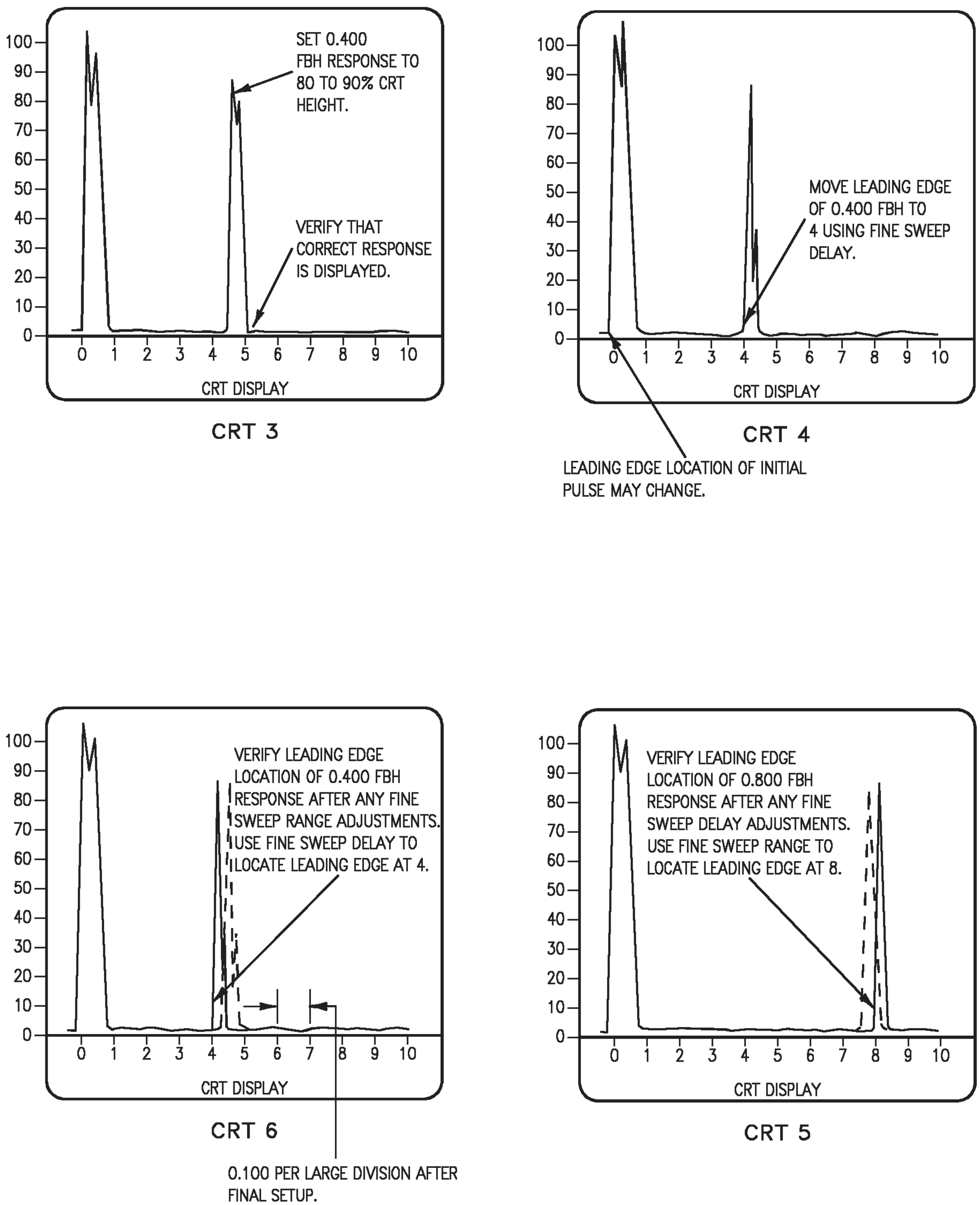


CRT 2

MAJOR CHANGE

18AC-SRM-30-(54-1)34-CATI

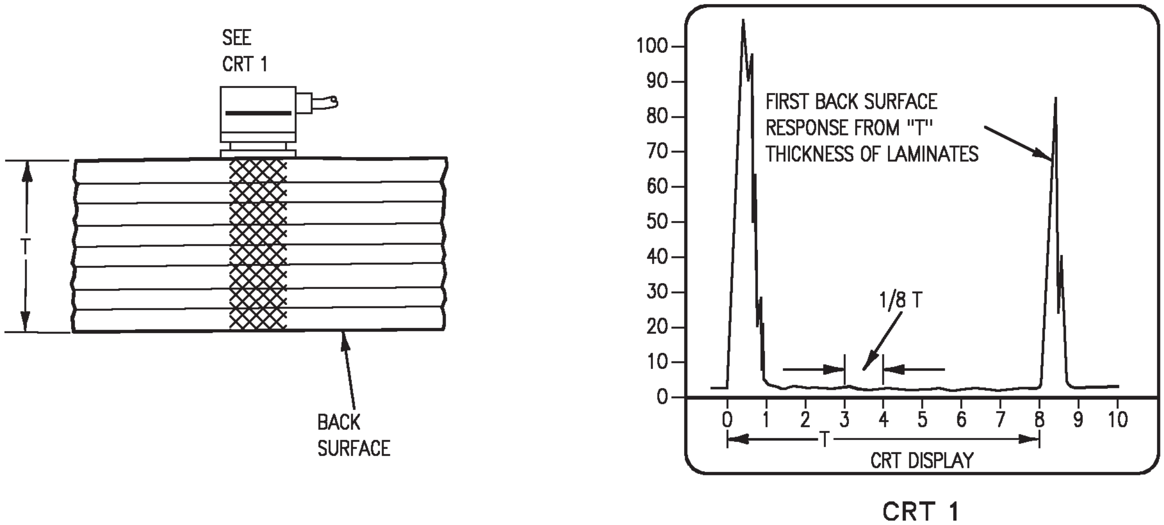
Figure 4. Setup For 0.950 Inch Composite (Sheet 1)



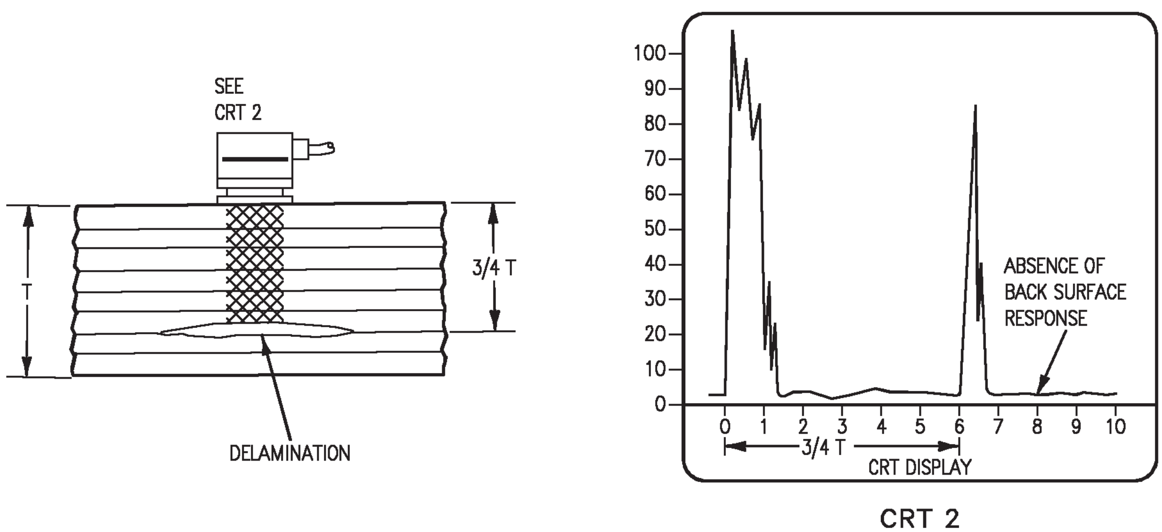
MAJOR CHANGE

18AC-SRM-30-(54-2)34-CATI

Figure 4. Setup for 0.950 Inch Composite (Sheet 2)



(A) FLAW FREE LAMINATE

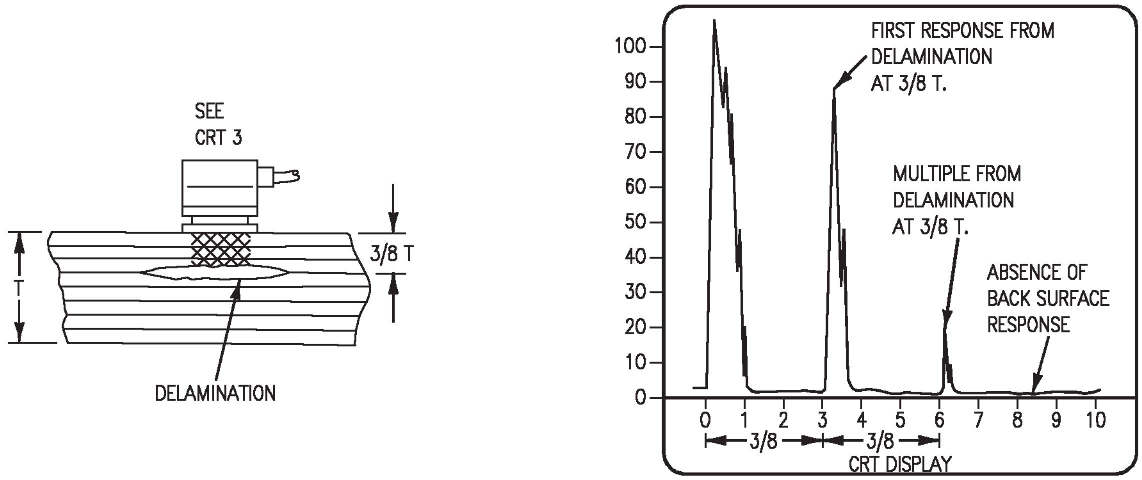


(B) SINGLE LEVEL DELAMINATION

MAJOR CHANGE

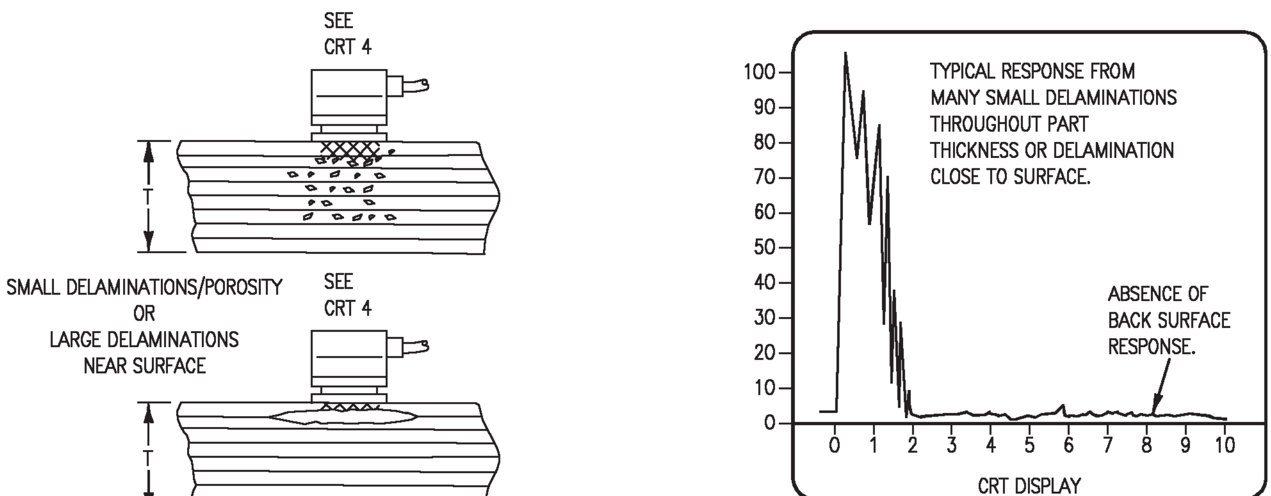
18AC-SRM-30-(58-1)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 1)



CRT 3

(C) SINGLE LEVEL DELAMINATION AND MULTIPLES



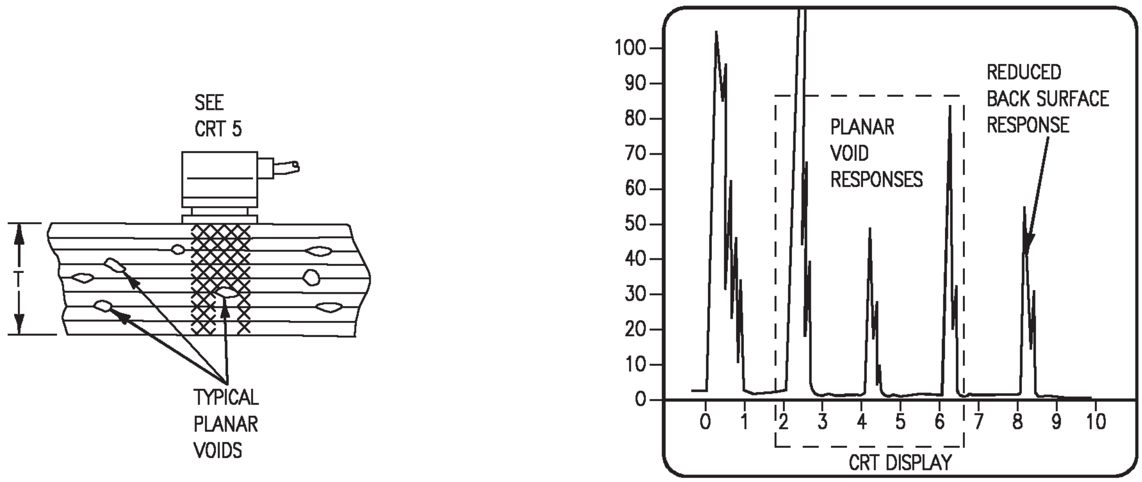
CRT 4

(D) SMALL DELAMINATIONS/POROSITY OR LARGE NEAR SURFACE DELAMINATION

MAJOR CHANGE

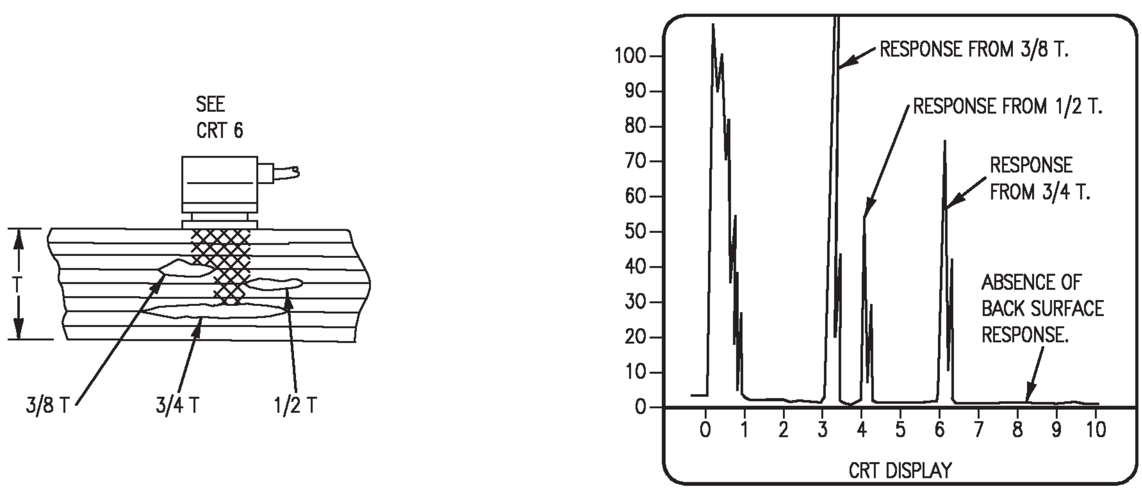
18AC-SRM-30-(58-2)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 2)



CRT 5

(E) PLANAR VOIDS



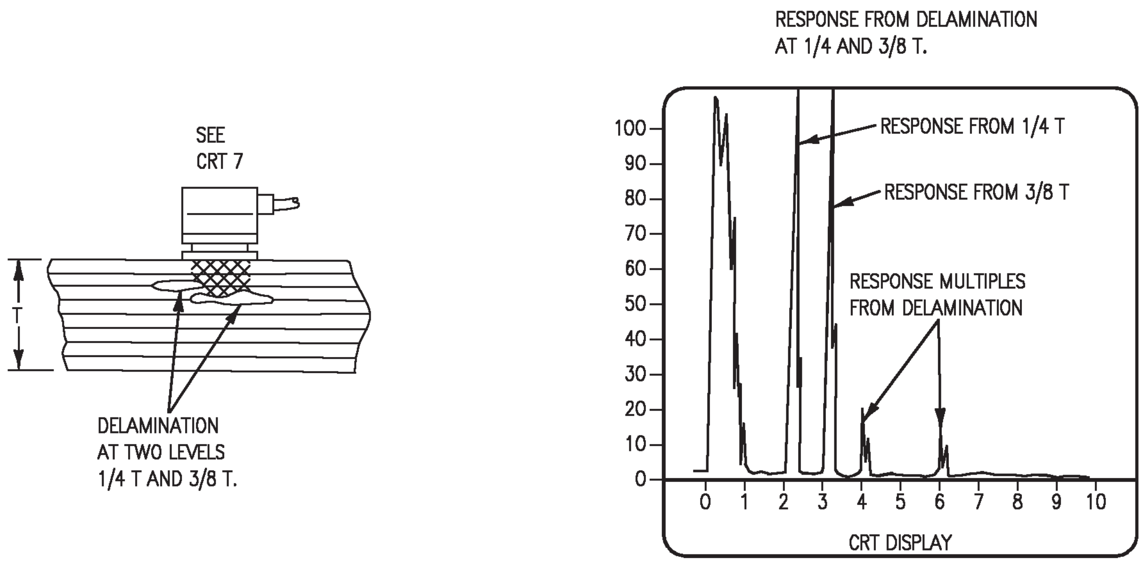
CRT 6

(F) MULTIPLE LEVEL DELAMINATION

MAJOR CHANGE

18AC-SRM-30-(58-3)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 3)



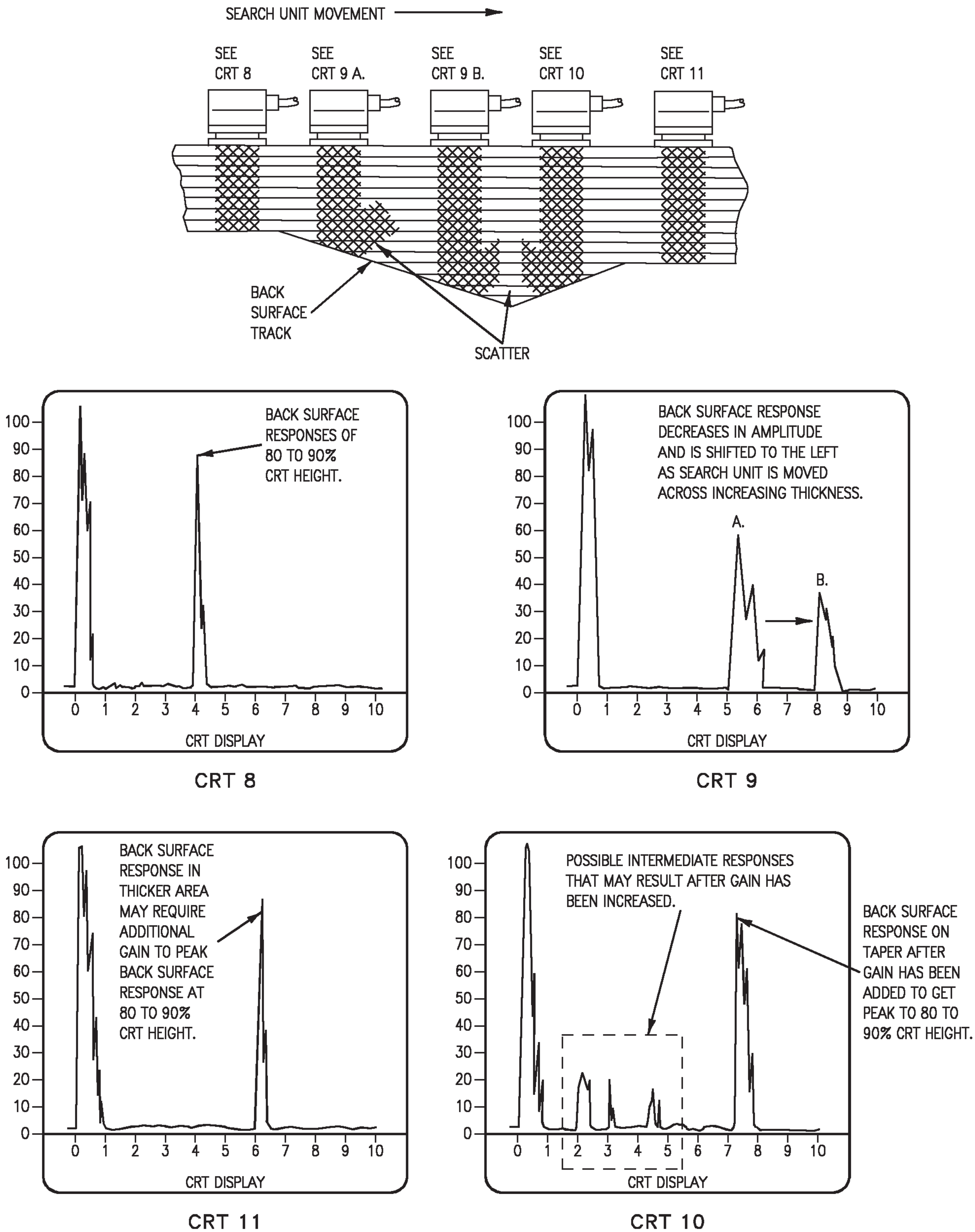
CRT 7

(G) TWO LEVEL DELAMINATION AND MULTIPLES

MAJOR CHANGE

18AC-SRM-30-(58-4)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 4)

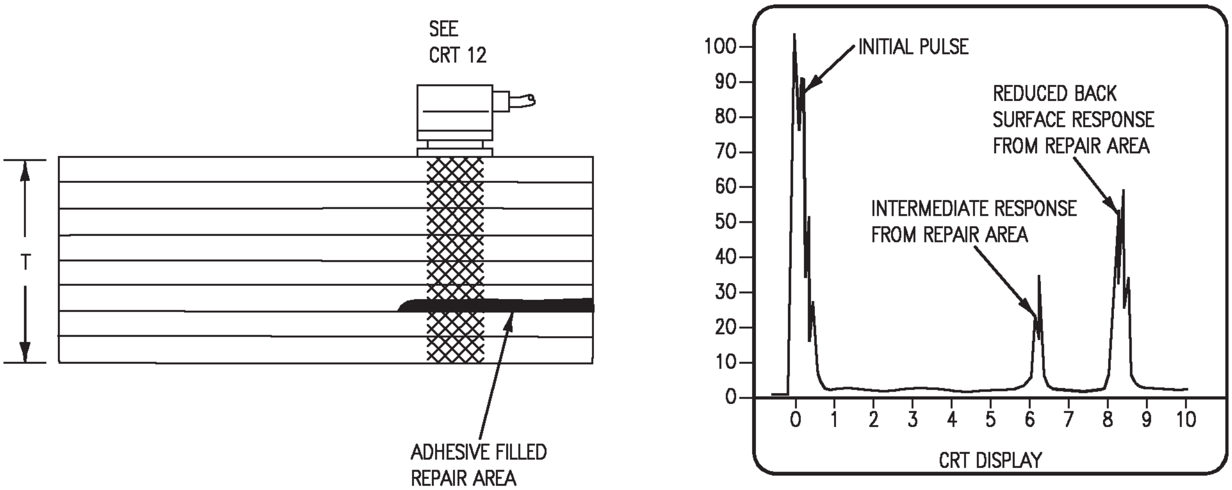


(H) SEARCH UNIT MOVEMENT ACROSS TAPER

MAJOR CHANGE

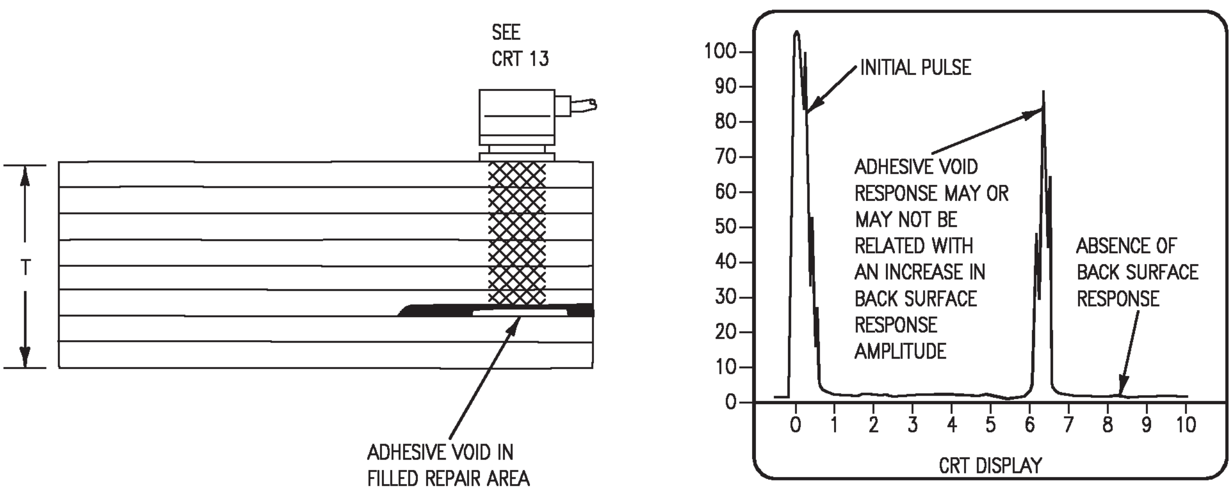
18AC-SRM-30-(58-5)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 5)



CRT 12

(I) ADHESIVE FILLED REPAIR AREA



CRT 13

(J) ADHESIVE VOID IN FILLED REPAIR AREA

MAJOR CHANGE

18AC-SRM-30-(58-6)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 6)

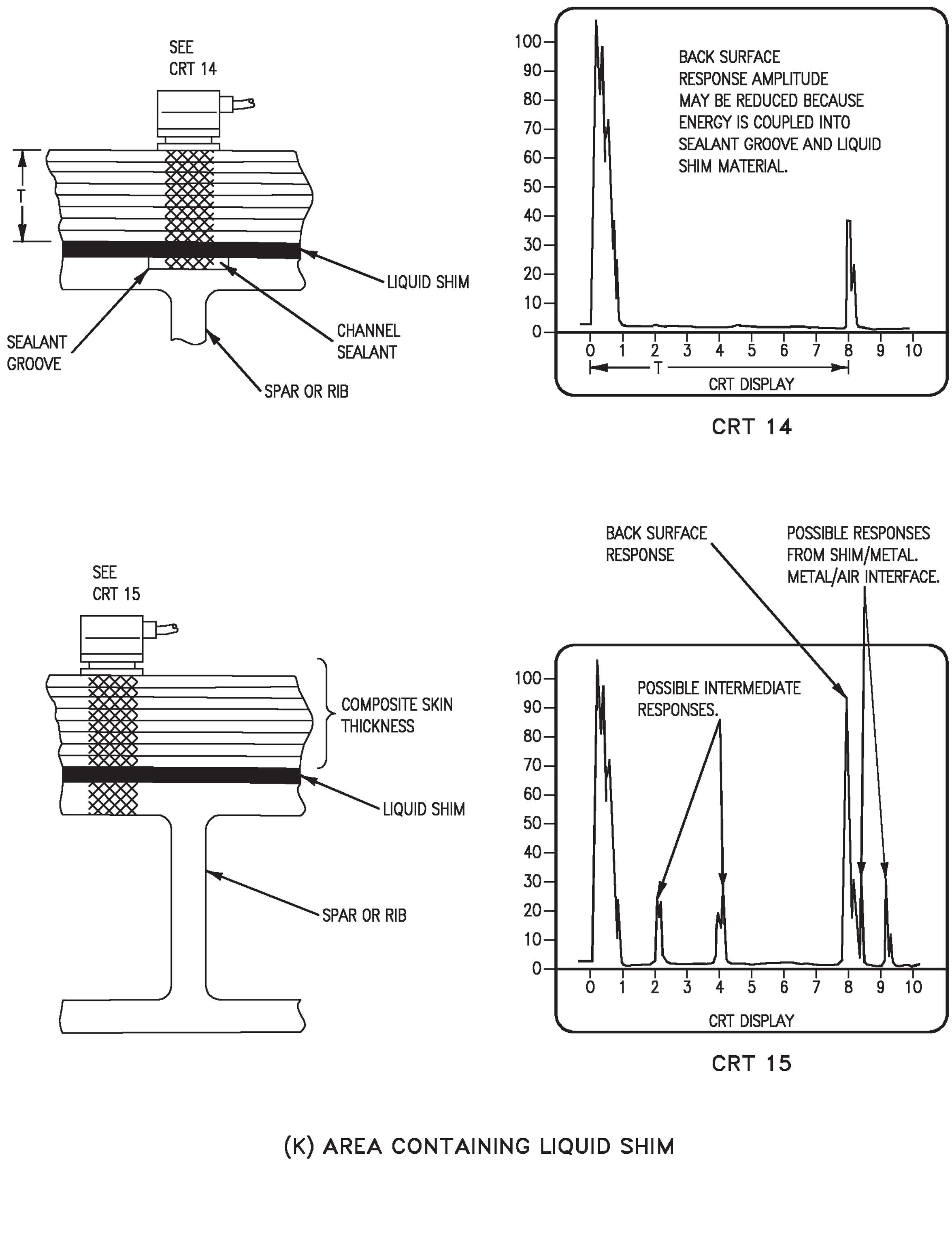
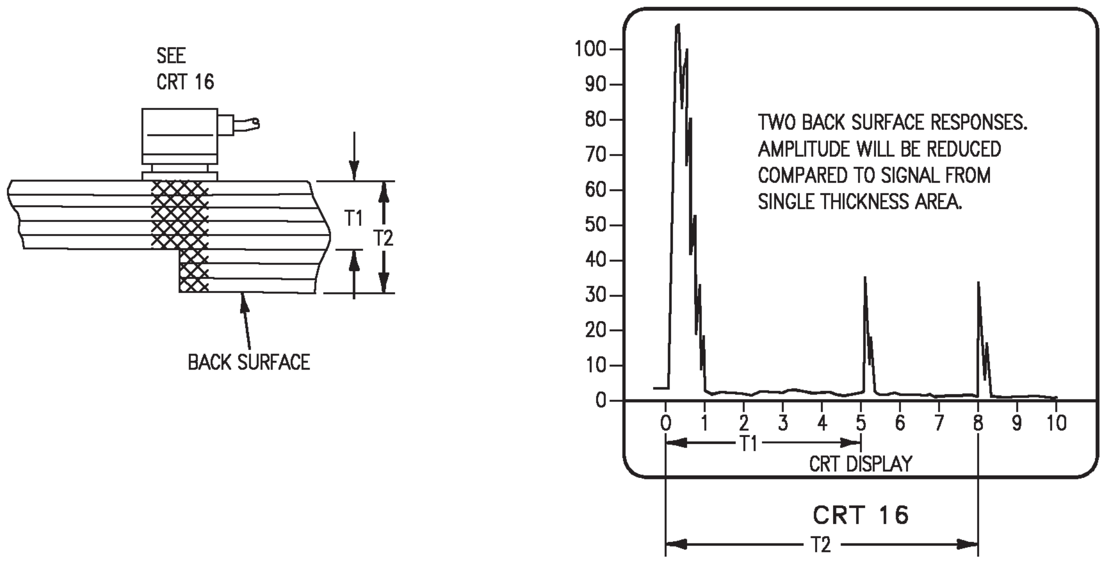


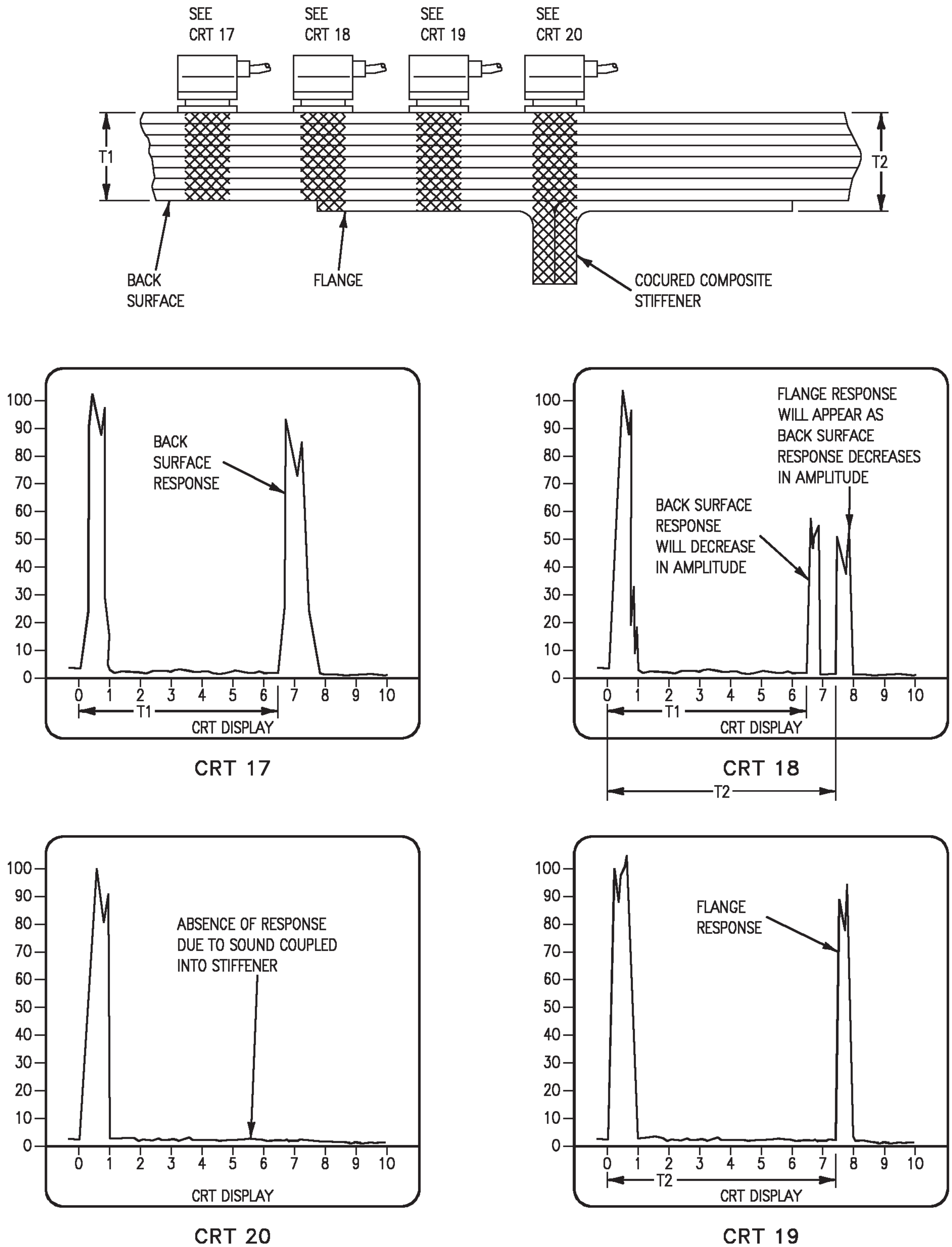
Figure 5. Laminate Inspection Responses (Sheet 7)



(I) THICKNESS CHANGE

18AC-SRM-30-(58-8)34-CATI

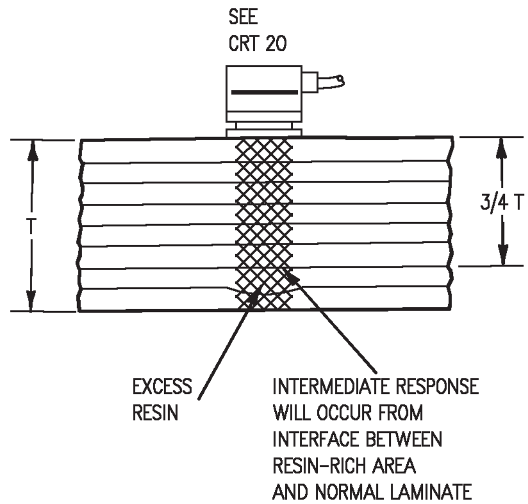
Figure 5. Laminate Inspection Responses (Sheet 8)

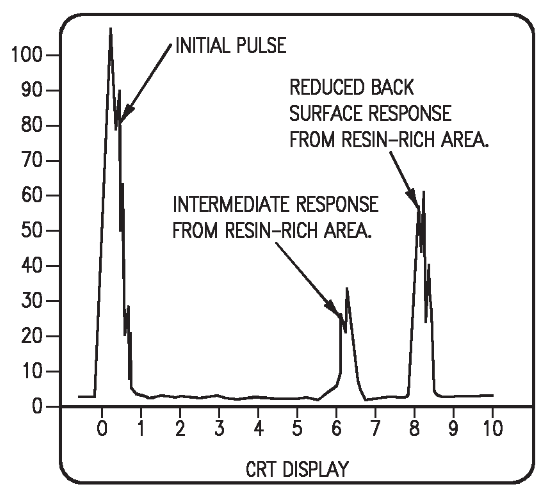


(M) COCURED COMPOSITE STIFFENER

18AC-SRM-30-(58-9)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 9)



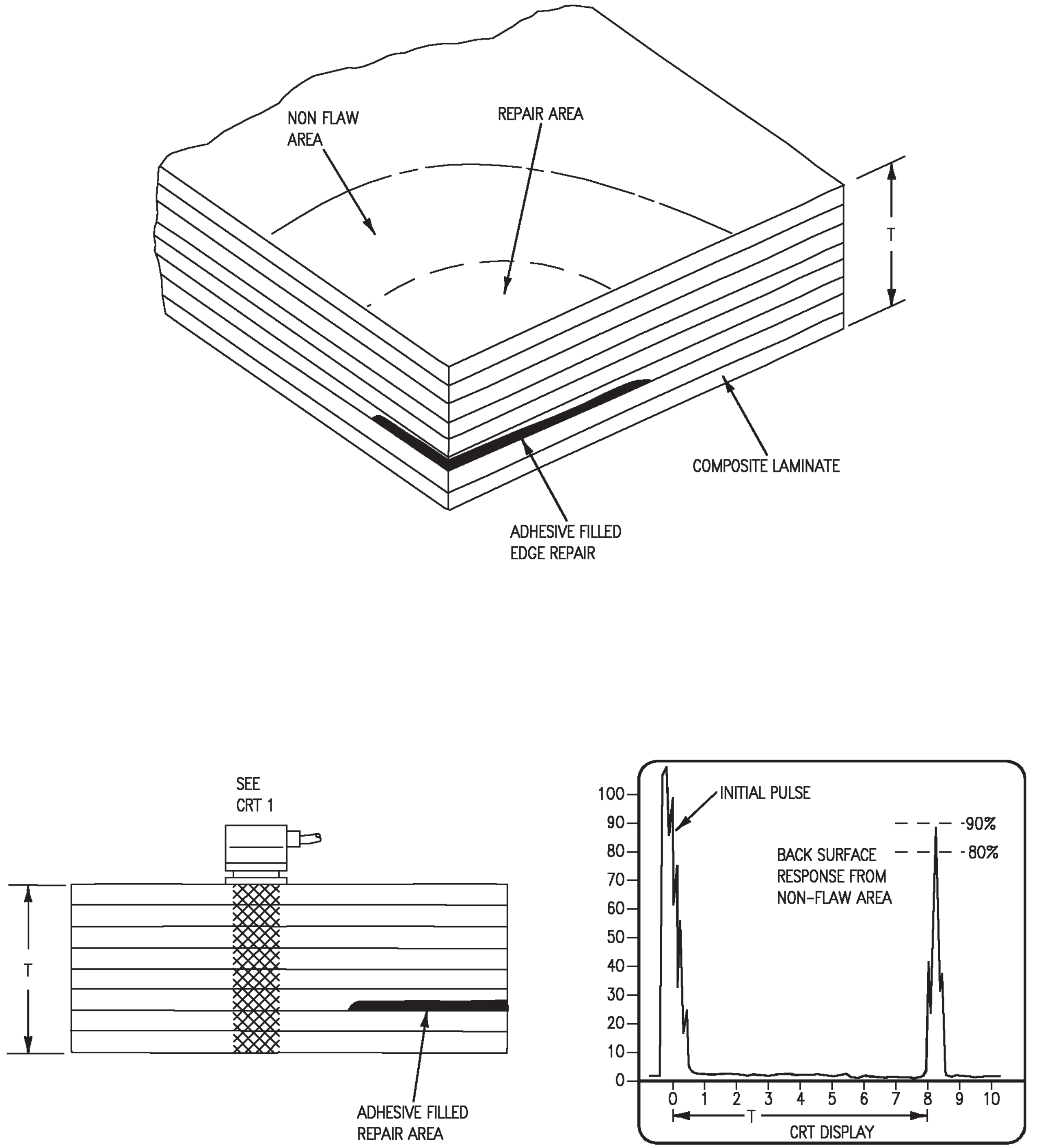


CRT 21

(N) EXCESS RESIN

18AC-SRM-30-(58-10)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 10)



CRT 1

MAJOR CHANGE

18AC-SRM-30-(62-1)34-SCAN

Figure 6. Edge Fill Repair Inspection

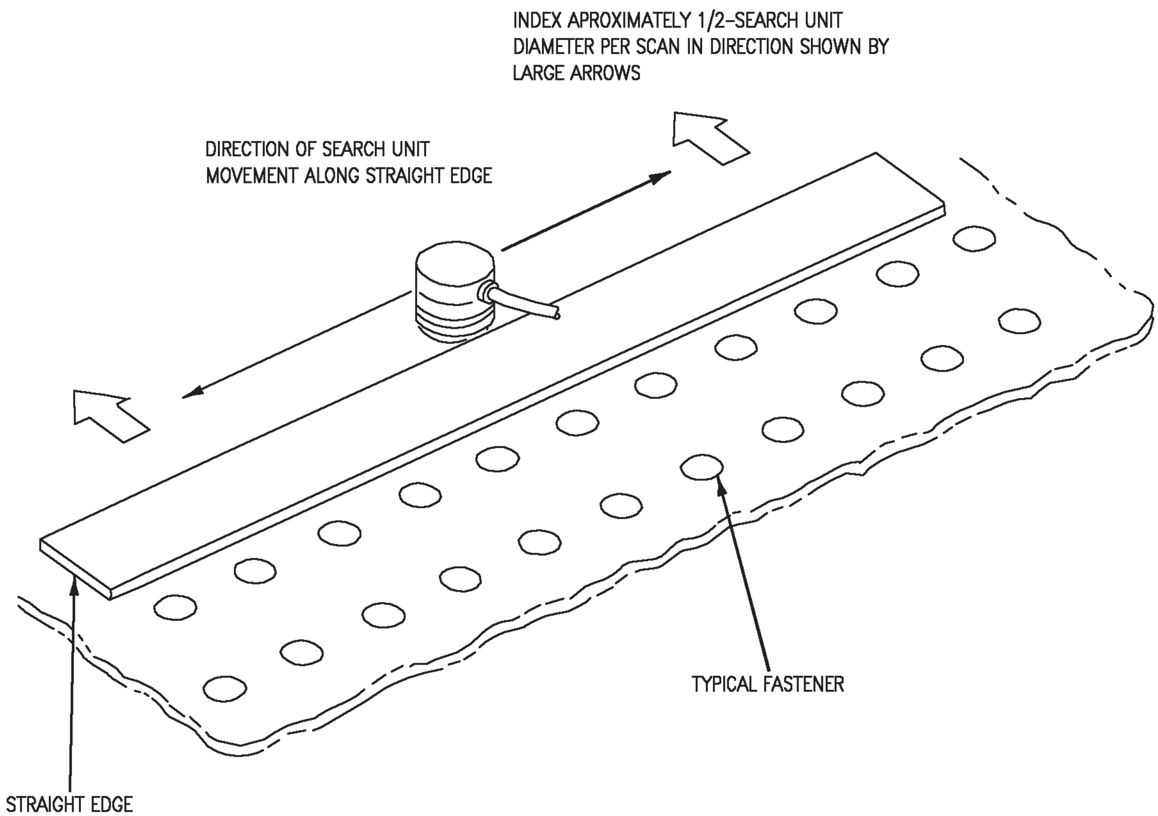
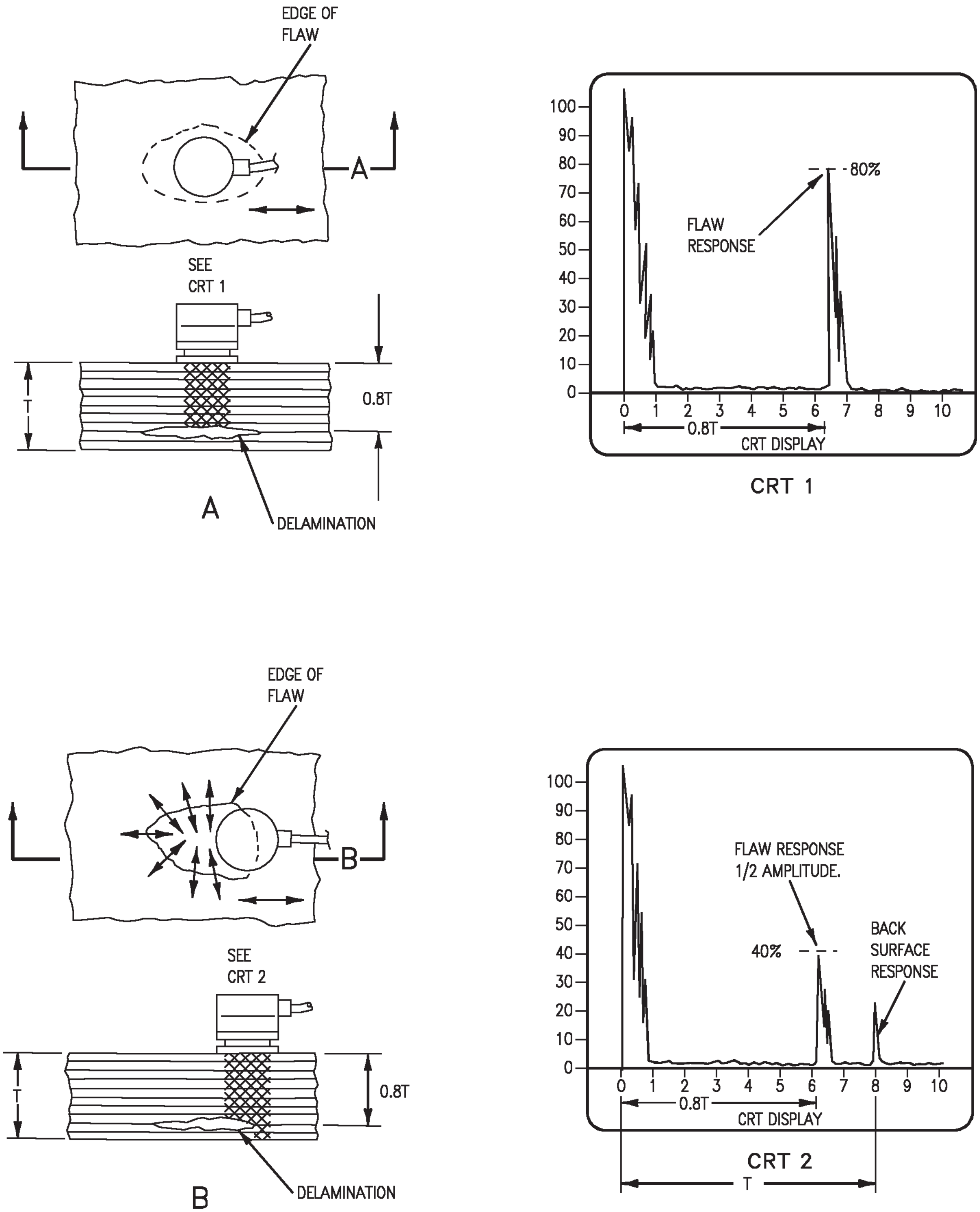


Figure 7. Scanning Method



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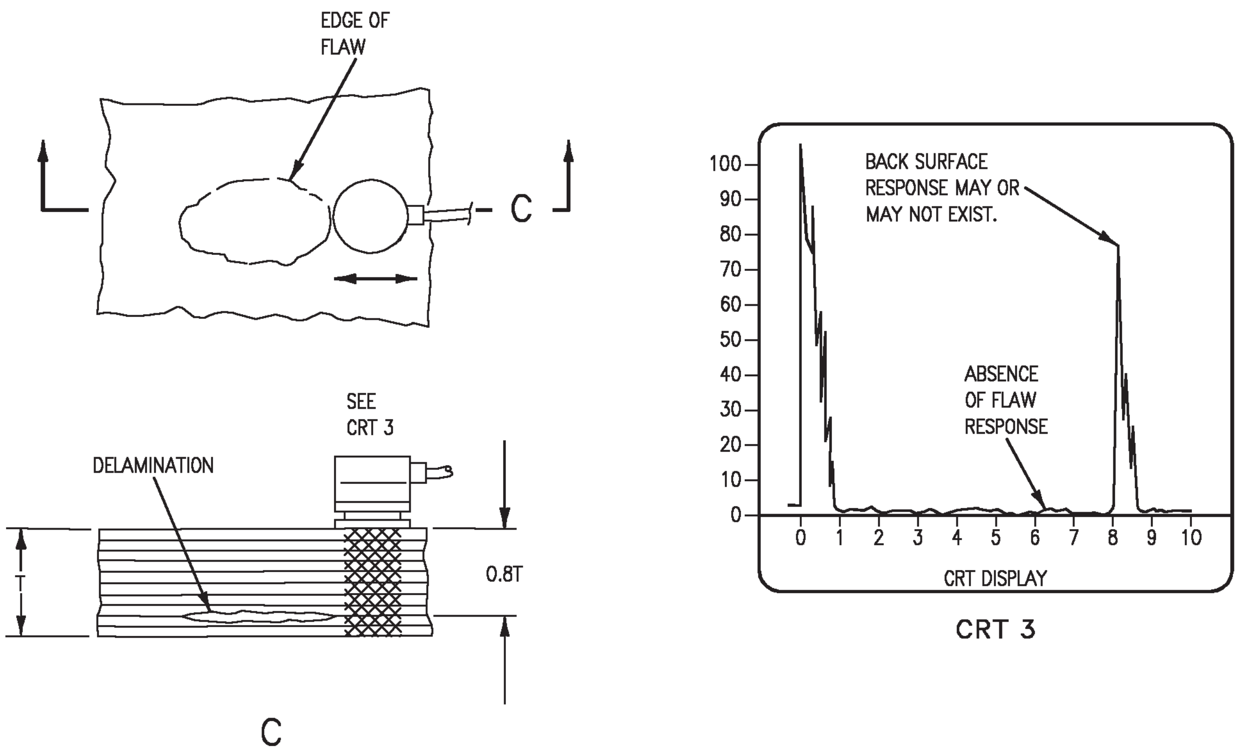
18AC-SRM-30-(60-1)34-SCAN

Figure 8. Half Amplitude Mapping (Sheet 1)



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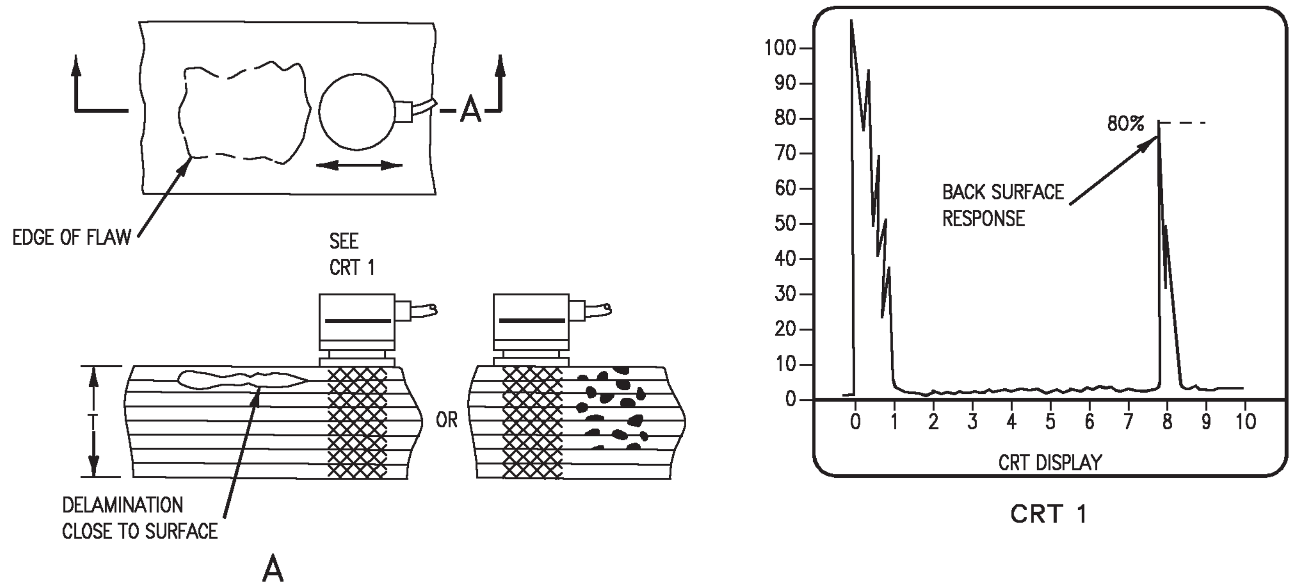
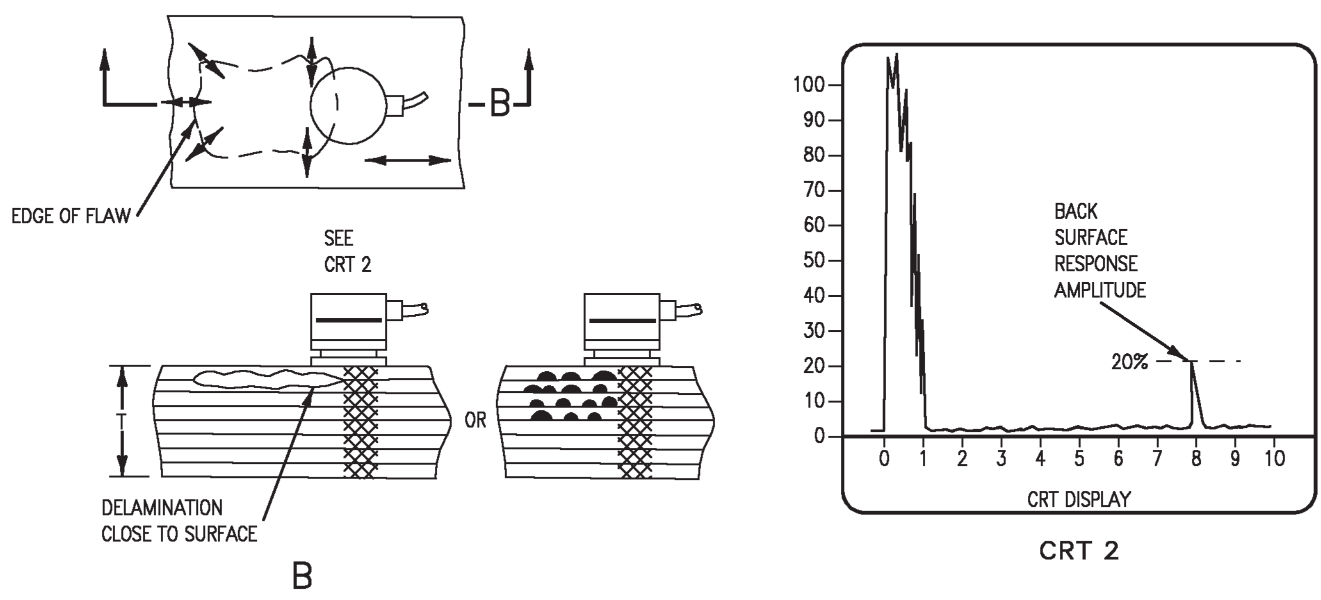
18AC-SRM-30-(60-2)34-SCAN

Figure 8. Half Amplitude Mapping (Sheet 2)

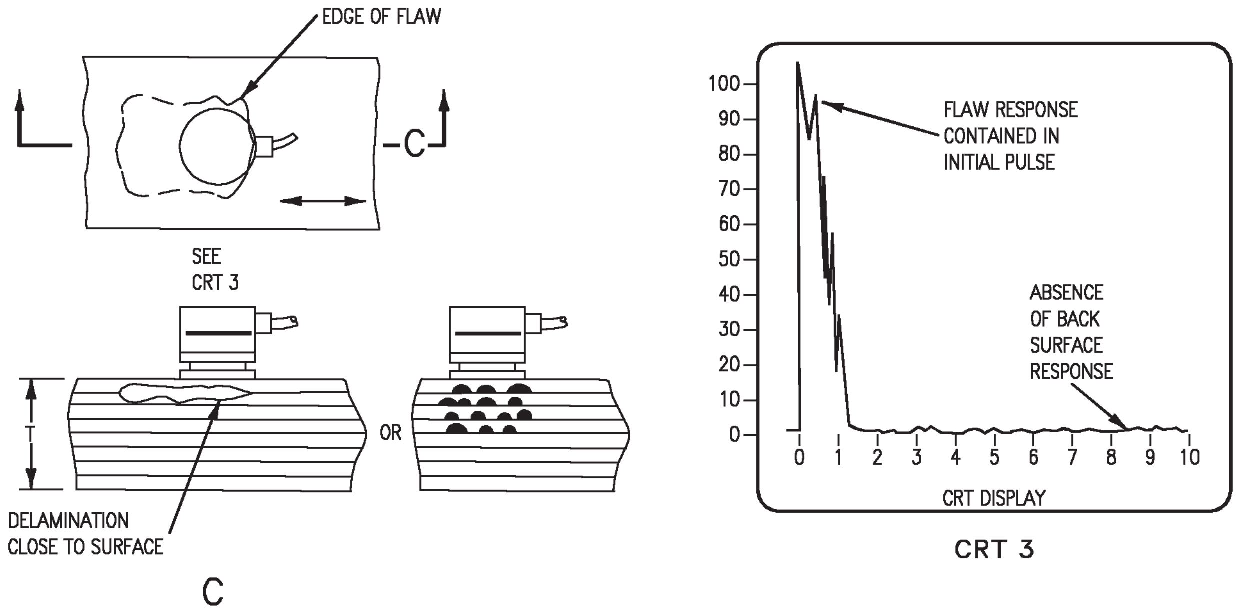




MAJOR CHANGE

18AC-SRM-30-(61-1)34-SCAN

Figure 9. Amplitude Mapping For Flaws Close to Surface (Sheet 1)



MAJOR CHANGE

18AC-SRM-30-(61-2)34-SCAN

Figure 9. Amplitude Mapping For Flaws Close to Surface (Sheet 2)

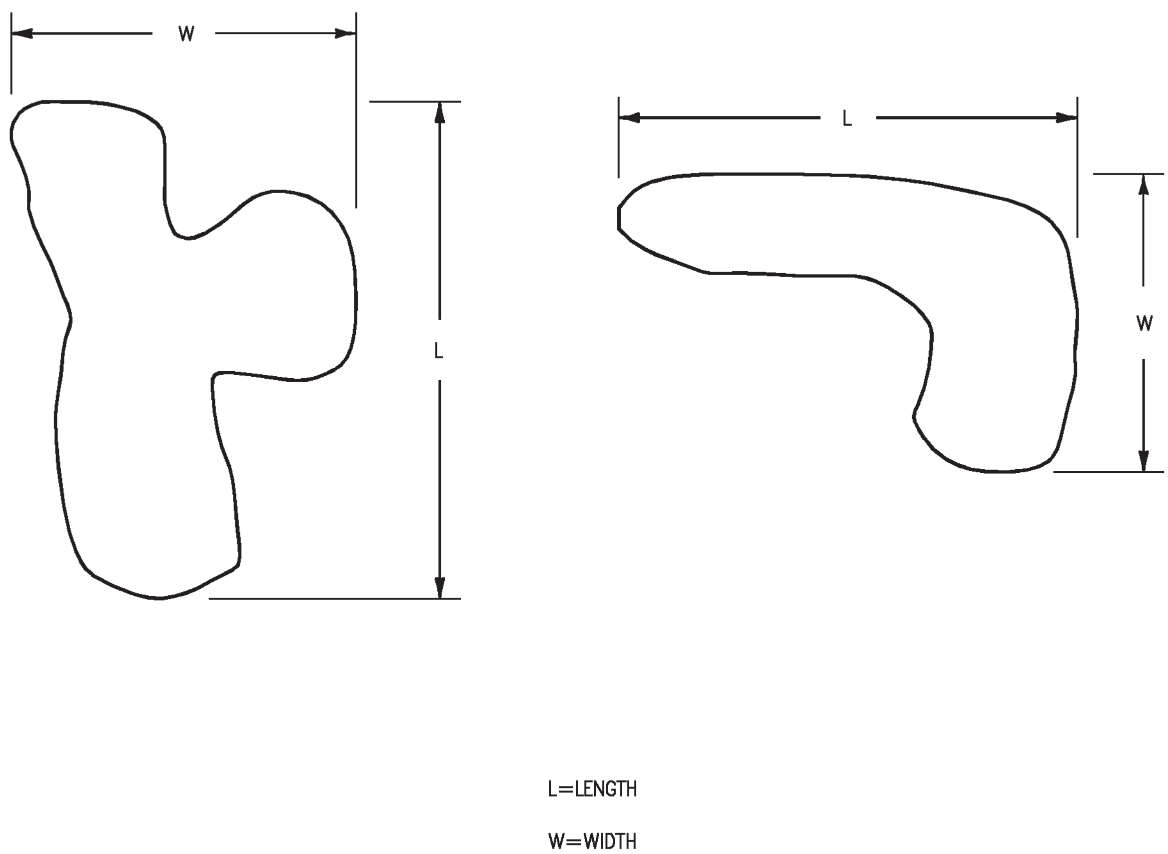


Figure 10. Half Amplitude Mapping, Smooth Curve

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO, LONGITUDINAL WAVE CONTACT, WITH DELAY LINE, FOR COMPOSITE LAMINATE MATERIAL

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed, longitudinal, ultrasonic waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Delay line is used as standoff and often improves near surface resolution.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical (static) grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2, NDI Technicians, NEC

7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
GD 0504 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Delay Line Search units
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cable.

b. Connect BNC end of connecting cable to T or R BNC jacks on tester.

c. Turn tester ON, allow 15 minutes warm-up.

NOTE

Tester settings listed here are given as initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP, FREQ., GAIN, REJECT, and FINE SWEEP RANGE, and LENGTH.

d. Set tester front face settings;

NOTE

Equipment differences may require use of alternate COARSE SWEEP RANGE, FREQ, REP RATE, FINE SWEEP RANGE, VIDEO DISPLAY, DAMPING, and REJECT settings.

COARSE SWEEP RANGE	0.5 INCH
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0-3 INCHES
FREQ	SAME AS SEARCH UNIT

MODE	PULSE-ECHO
FINE GAIN....................	MAX
REP RATE.....................	AUTO
FINE SWEEP RANGE..........................	MIN
DAMPING......................	APPROX MID SCALE
REJECT..........................	APPROX 0
VIDEO DISPLAY	EITHER +, –, or FULL WAVE

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water moistened cloth, or cleaning compound, as required, to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY until initial pulse is located at zero on CRT horizontal baseline. First response from delay line/air interface may also be visible. See figure 1, CRT 1.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

NOTE

During damping, amplitude of delay line/air interface response should decrease, but initial pulse amplitude should remain constant.

h. Adjust FINE SWEEP RANGE, DELAY, and GAIN so first delay line/air interface response is visible on CRT horizontal baseline while initial pulse is still visible. Damp end of delay line with finger to get reduction in peak amplitude, and verify correct response is being viewed. See figure 1, CRT 2.

i. After delay line/air interface response has been identified, use FINE SWEEP DELAY to locate this response at zero on CRT horizontal baseline. See figure 1, CRT 3.

NOTE

If second delay line/air interface response is not visible, increase GAIN to see if response appears. If increasing GAIN causes second response to appear, first damp transducer with finger to verify response is second delay line/air interface response and is not noise due to increased gain. Next, adjust FINE SWEEP RANGE to locate second delay line/air response off screen. Return GAIN to previous setting.

j. Second delay line/air interface response may be visible if certain settings have been selected. See figure 1, CRT 3. Second response may be moved off CRT or located beyond 10 on CRT horizontal baseline by adjusting FINE SWEEP RANGE. It is desirable to work in time period between first and second delay line interface responses. See figure 1, CRT 4.

k. After making adjustments to move second delay line/air response off CRT screen, make sure first delay line/air interface response is still located at zero on CRT horizontal baseline. Adjust FINE SWEEP RANGE to relocate response to zero if it is not. See figure 1, CRT 4. Tester is now ready for time-base standardization.

CAUTION

Do not use grease pencil or otherwise mark on face of CRT filter. Damage to components will occur.

6. **TIME-BASE STANDARDIZATION.**

7. **Composite Laminates Up to 0.190 Inch Thick.** This time base standardization is required because delaminations in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been setup to represent 0.020 inch of material, then unknown response located at 5 large divisions on CRT horizontal baseline represents 0.100 inch of setup material. Full scale response at 10 on CRT horizontal baseline would then be equivalent to 0.200 inch of composite material after setup. Use flat bottom hole (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of the 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 1, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard in Figure 2 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, number preceding FBH represents material thickness/depth (inches) above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set, over 0.100 FBH.

c. Position search unit over 0.100 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 3, CRT 1.

e. Damp bottom, or reflecting surface, of FBH to make sure correct response if being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT. Minimum REJECT is recommended.

f. Use DAMP, REJECT, and FILTER to optimize response and remove couplant from reflecting surface continuing.

g. With response peak located at 80 to 90 percent CRT height, use FINE SWEEP RANGE to locate leading edge of 0.100 FBH response at 5 on CRT horizontal baseline. See figure 3, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.040 FBH.

i. Position search unit over 0.040 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back surface response from 0.040 FBH is 80 to 90 percent CRT height. See figure 3, CRT 3. Response multiples may or may not be visible.

k. Damp bottom, or reflecting surface, of 0.040 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent height, use FINE SWEEP DELAY to locate leading edge of 0.040 FBH response at 2 on CRT horizontal baseline. See figure 3, CRT 4.

m. Reposition search unit over 0.100 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position of 0.100 FBH response is still located at 5 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP RANGE to relocate leading edge of 0.100 FBH response at 5 when response peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 5.

n. After any changes in FINE SWEEP RANGE, reposition search unit over 0.040 FBH and adjust GAIN, probably decrease, so 0.040 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP RANGE to relocate 0.040 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times as required. Verify correct leading edge locations of responses from 0.100 and 0.040 FBHs when peak amplitudes are 80 to 90 percent CRT height after any changes in either FINE SWEEP RANGE or DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates materials up to 0.190. Each large division on CRT horizontal baseline represents 0.020. See figure 3, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth is accurately known. FBH response leading edge location should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.020 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

r. Tester is now standardized for inspection of composite laminates up to 0.190 inch thick.

8. **Composite Laminates Up to 0.450 Inch Thick.** Time base standardization is required because delaminations in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been set up to represent 0.050 of material, unknown response located at 5 large divisions on CRT horizontal baseline represents 0.250 inch of setup material. Full scale response at 10 on CRT horizontal baseline would then be equivalent to 0.500 of composite material after setup. Use (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 2, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard of Figure 1 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, number before FBH represents material thickness/depth above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set, over 0.400 FBH.

c. Position search unit over 0.400 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.400 FBH is 80 to 90 percent height. See figure 4, CRT 1.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH. Damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

e. Damp bottom, or reflecting surface, of 0.400 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Minimum REJECT is recommended.

f. Use DAMP. REJECT, and FILTER to optimize response and remove baseline noise. Remove couplant from reflecting surface before continuing.

g. With response peak located at 80 to 90 percent CRT height, use FINE SWEEP RANGE to locate leading edge of 0.400 FBH response at 8 on CRT horizontal baseline. See figure 4, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.100 FBH.

i. Position search unit over 0.100 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back response from 0.100 FBH is 80 to 90 percent CRT height. See figure 4, CRT 3.

k. Damp bottom, or reflecting surface, of 0.100 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent height, use FINE SWEEP DELAY to locate leading edge of 0.100 FBH response at 2 on CRT horizontal baseline. See figure 4, CRT 4.

m. Reposition search unit over 0.400 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position and 0.400 FBH response is still located at 8 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP RANGE to relocate leading edge of 0.400 FBH response at 8 when response peak amplitude is 80 to 90 percent CRT height. See figure 4, CRT 5.

n. After any changes in FINE SWEEP RANGE, reposition search unit over 0.100 FBH and adjust GAIN, probably decrease, so 0.100 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP DELAY to locate 0.100 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times, as required. Verify correct leading edge locations of responses from 0.400 and 0.100 FBHs when peak amplitudes are 80 to 90 percent CRT height after any changes in either HORIZONTAL SWEEP FINE DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminate materials up to 0.450 inch thick. Each large division on CRT horizontal baseline divisions represents 0.050 inch of material. See figure 4, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth are accurately known. FBH response leading edge should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.050 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

r. Tester is now standardized for inspection of composite laminates up to 0.450inch thick.

9. **INSPECTION PROCEDURES.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cloth moistened cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

b. Before beginning inspection, determine locations of ply changes, rabbets, stiffeners, and other items lying beneath surface of area to be inspected. This information should be described in specific procedure work packages. Lay out locations of ply changes, rabbets, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar overlay. Also include applicable thicknesses of part or areas of part on overlay.

c. To make sure large parts are completely inspected, mark a grid pattern(s) on inspection area per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 inch grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5, 6, 7, and 8 for composite thickness of part being inspected.

WARNING

Clouplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit face wear should be parallel to back surface of laminate. See figure 5, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 5, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 of search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 6. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at a rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid block.

i. Use guidelines given in paragraph 10. on CRT interpretation to identify flaws.

j. Once a flaw has been identified, use pulse-echo mapping technique shown in figure 7 and described in paragraph 20.a. for 1/2 amplitude mapping, and figure 8, paragraph 20. b. for mapping flaws close to surface or small multiple delaminations to determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge or by using delay line technique when defect is closer to surface.

k. Mark flaws indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

10. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, back surface response, and possibly back surface response multiples should be visible on CRT. Back surface response should be located at CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 5, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed before inspection, described in paragraphs 5, 6, 7, and 8.

11. **Single Level Delamination .** Delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 5, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 5, CRT 3.

12. **Small Delaminations and Large Near Surface Delaminations.** Small delaminations throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 5, CRT 4.

NOTE

If not clear whether indication is due to near surface delamination or presence of heavy porosity, and back surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates that delamination is present. If small response is detected, it is likely that area contains heavy porosity.

13. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate response may be due to numerous planar voids and multiples from single planar voids. See figure 5, CRT 5.

14. **Multiple Level Delaminations.** Appearance of more than one intermediate response and absence of back-surface response may indicate multiple level delamination. See figure 5, CRT 6. Depending on depth of each delamination level, multiples from various levels may also appear. See figure 5, CRT 7.

NOTE

Too much gain may result in sensitivity level where meaningless responses will appear. Increasing gain may get intermediate response multiples.

15. **Tapers.** Tapers should be described in specific work package or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-700 through A1-F18AE-SRM-750). When search unit is placed over area outside of taper, where front and back surfaces of part are parallel, back surface response will appear at CRT horizontal baseline corresponding to part thickness at that point. Gain should be adjusted so back surface response at such point is 80 to 90 percent CRT height. See figure 5, CRT 8. As search unit is moved across area of taper in which thickness of part is increasing, back surface response will decrease in amplitude and move away from initial pule. See figure 5, CRT 9. As search unit is moved across area of taper in which thickness of part is decreasing, back surface response will increase in amplitude and move toward initial pulse. If back surface amplitude is significantly decreased due to added thickness on taper, increase gain so back surface response is back up to 80 to 90 percent CRT height. See figure 5, CRT 10. Depending on the new part thickness when taper ends, gain may need to be adjusted again so back surface response is 80 to 90 percent CRT height. See figure 5, CRT 11. Intermediate responses may appear when gain is increased.

16. **Edge Repair.** Adhesive filled edge repair area will result in intermediate response from repair area and reduction in back surface amplitude due to attenuation from repair area. See figure 5, CRT 12. Repair area containing adhesive void will be indicated by intermediate response and absence of back surface response. Increase in amplitude of intermediate response compared flaw free repair area response is likely, but may not always happen. See figure 5, CRT 13.

17. **Liquid Shim.** When search unit is placed over laminate containing liquid shim between skin and substructure, several responses are possible. When search unit is placed over sealant groove, back surface amplitude may be reduced since energy is coupled into liquid shim and channel sealant. See figure 5, CRT 14. In other areas, where there is liquid shim between laminate and substructure, back surface response may be decreased in amplitude, since some energy is coupled into shim and substructure. Reflections from shim/substructure and substructure/air interfaces may appear. See figure 5, CRT 15. Rather than appearing as distinct responses to left of back surface response, back surface response be broadened and decreased in amplitude due to reflections from shim/substructure and substructure interfaces.

NOTE

When inspecting areas containing liquid shim, it may be required to increase gain to peak back surface response. Intermediate responses may occur when gain is increased.

18. **Abrupt Thickness Change.** Locations of abrupt thickness changes should be noted in specific work packages or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750). When search unit is placed over area containing thickness change, back surface response from each thickness will appear. Amplitude of each response will be reduced compared to signal from single thickness area. See figure 5, CRT 16.

19. **Cocured Composite Stiffener.** As search unit is moved across area containing cocured composite stiffener, variety of responses will occur. See figure 5, CRTs 17 through 20. Before search unit is placed over underlying stiffener, there should be back surface response, its amplitude between 80 and 90 percent height located at CRT horizontal baseline representing its thickness, T1. See figure 5, CRT 17. Moving search unit across laminate surface so it covers part of underlying composite flange, back surface response will decrease in amplitude as flange response appears. With half of search unit covering flange, both back surface and flange responses will have decreased amplitudes compared to original back surface response. Flange response will be located at CRT horizontal baseline location representing T2, sum of laminate and flange thicknesses. See figure 5, CRT 18. Depending on laminate and flange thicknesses as well as tester settings, laminate and flange responses may not be distinct so only one broadened response with reduced amplitude appears. When search unit is moved completely over flange, back surface response may completely disappear so only flange response appears. Flange response should have increased amplitude compared to responses when half of search unit covered flange, and should be located at CRT horizontal baseline division representing T2. See figure 5, CRT 19. Depending on thicknesses and flaw detector settings, small back surface response may still be present. When search unit is placed directly over stiffener, response may completely disappear since ultrasonic energy is coupled into stiffener. See figure 5, CRT 20. If stiffener is unbonded from laminate, back surface response will appear and will be located at CRT horizontal baseline division representing T1, laminate thickness. Amplitude of this response will depend on size of unbond, void, etc. at interface since defect size will determine amount of ultrasonic energy that is coupled into stiffener. Even if there are no defects at stiffener/back surface interface, small back surface response may be received at T1 location on CRT horizontal baseline.

20. **MAPPING.**

a. Half Amplitude Mapping.

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 7, CRT 1.

(3) Move search unit toward good areas in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude. See figure 7, CRTs 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping For Flaws Close to Surface or Small Multiple Delaminations.

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 8, CRT 1.

(3) Move search unit in toward flaw in all directions. Use aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent of CRT height. See figure 8, CRTs 2 and 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 9.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

21. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

22. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.

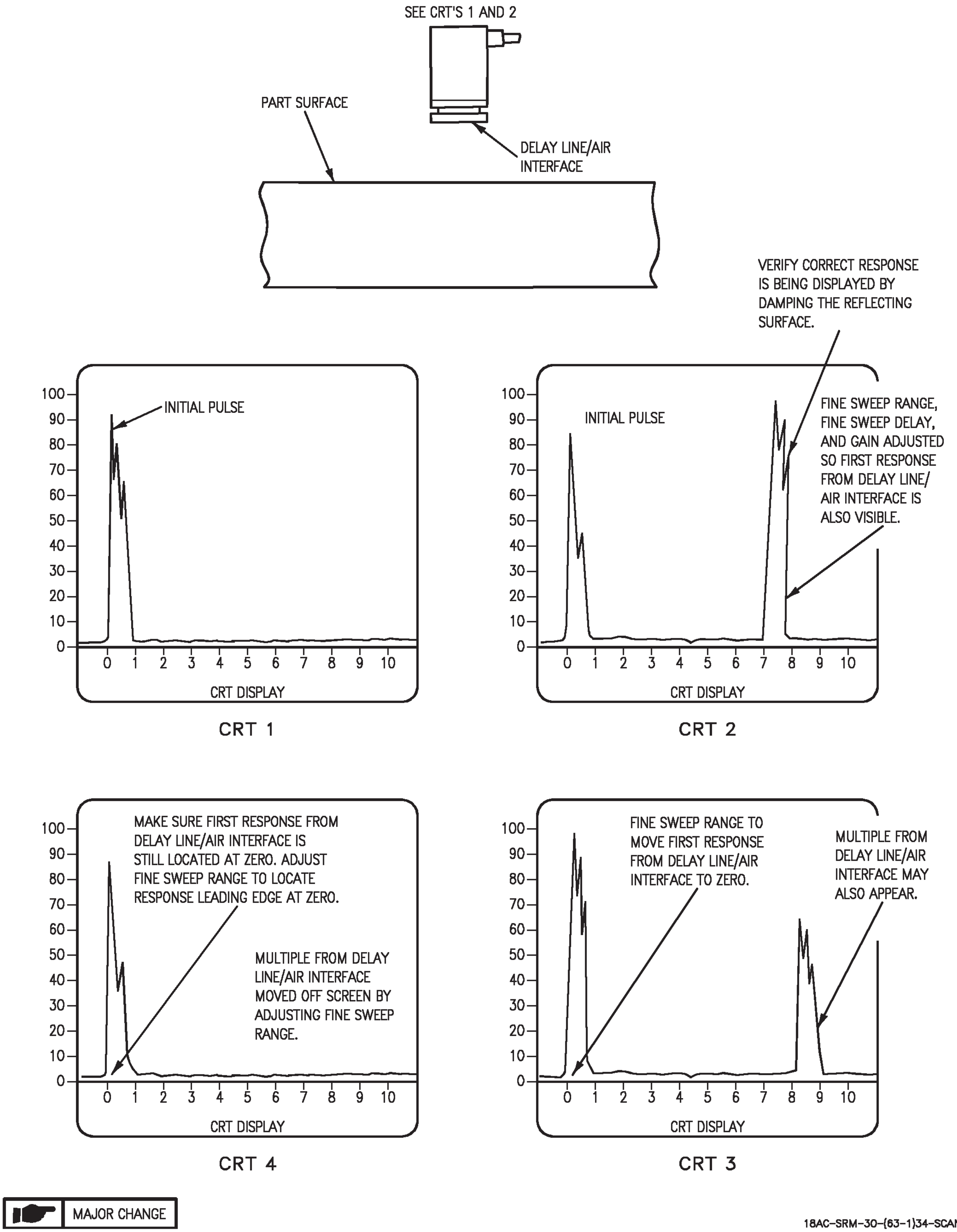


Figure 1. Initial Setup, 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit

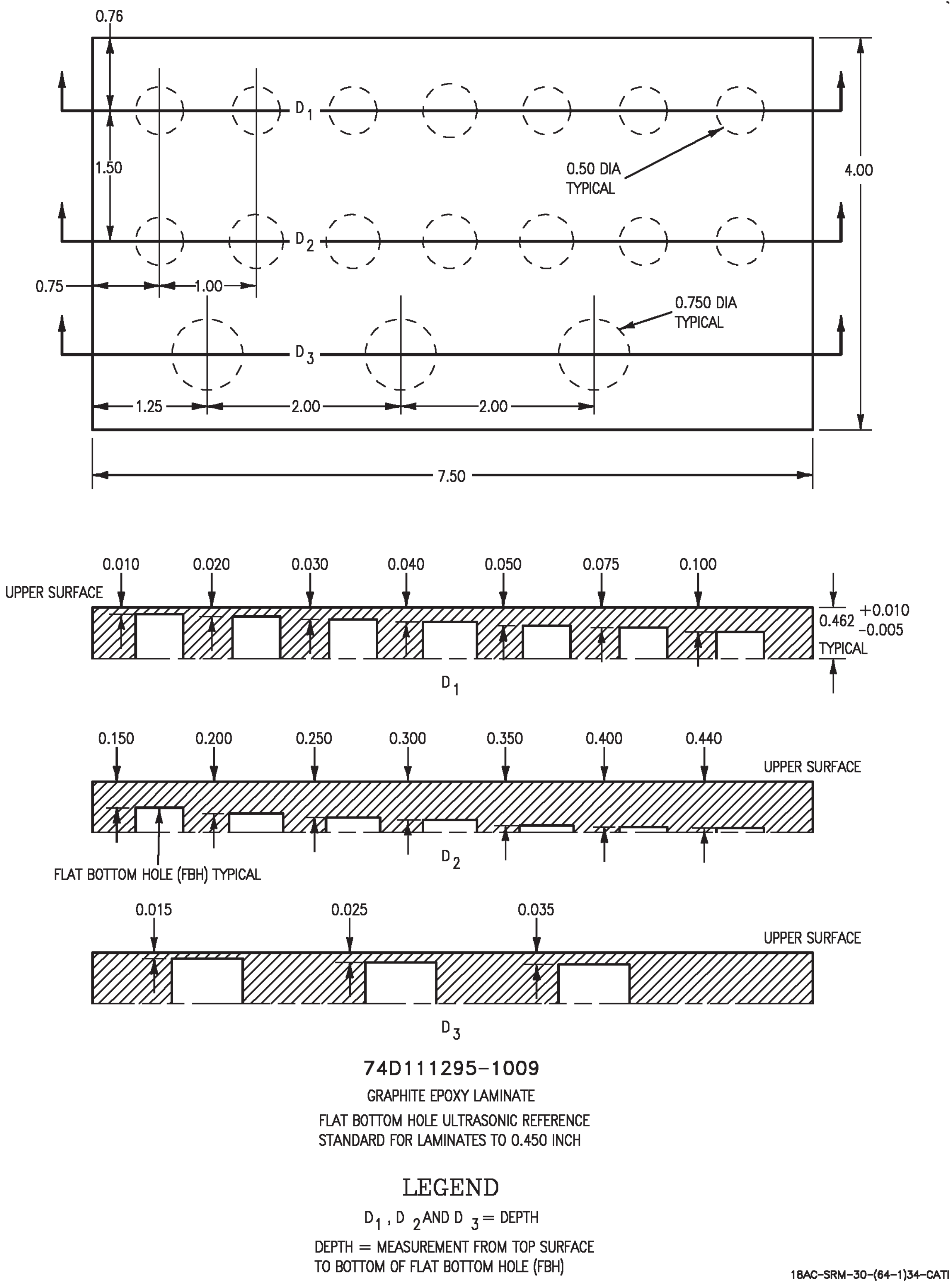
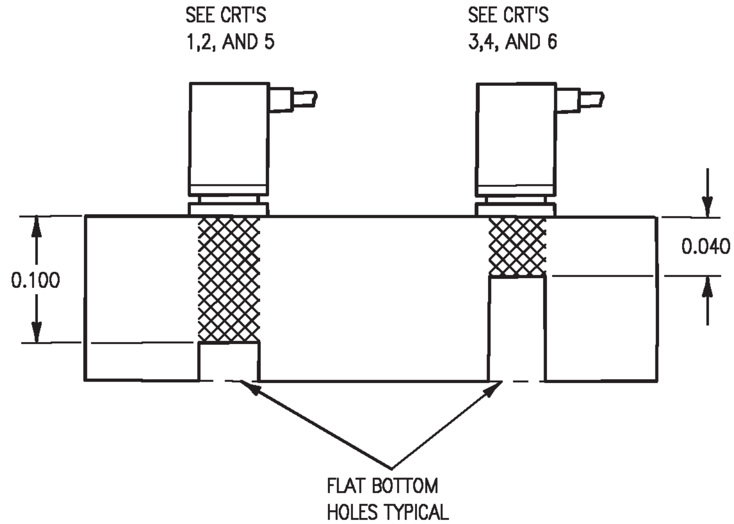
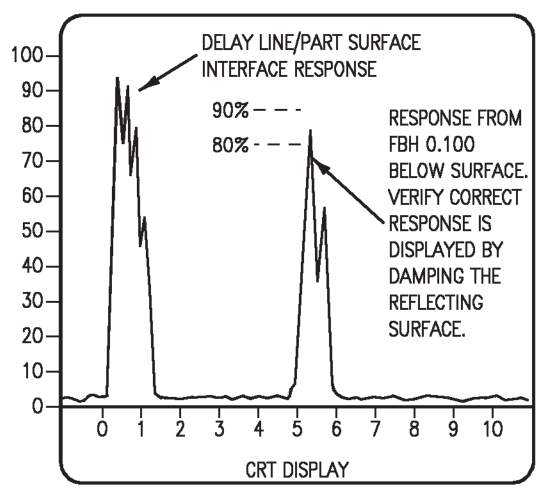
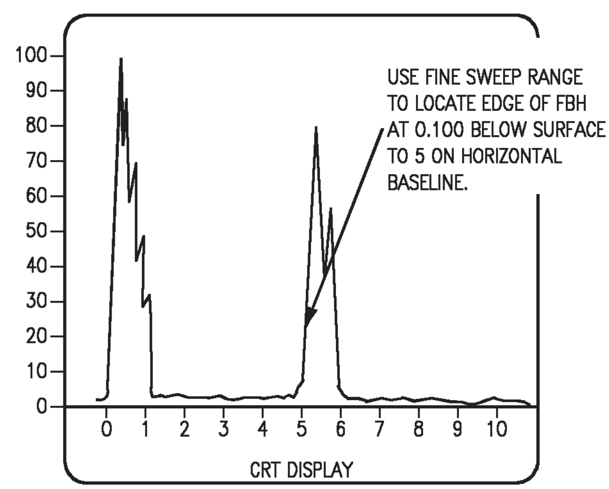


Figure 2. FBH Reference Standard for Delay Line Setup





CRT 1

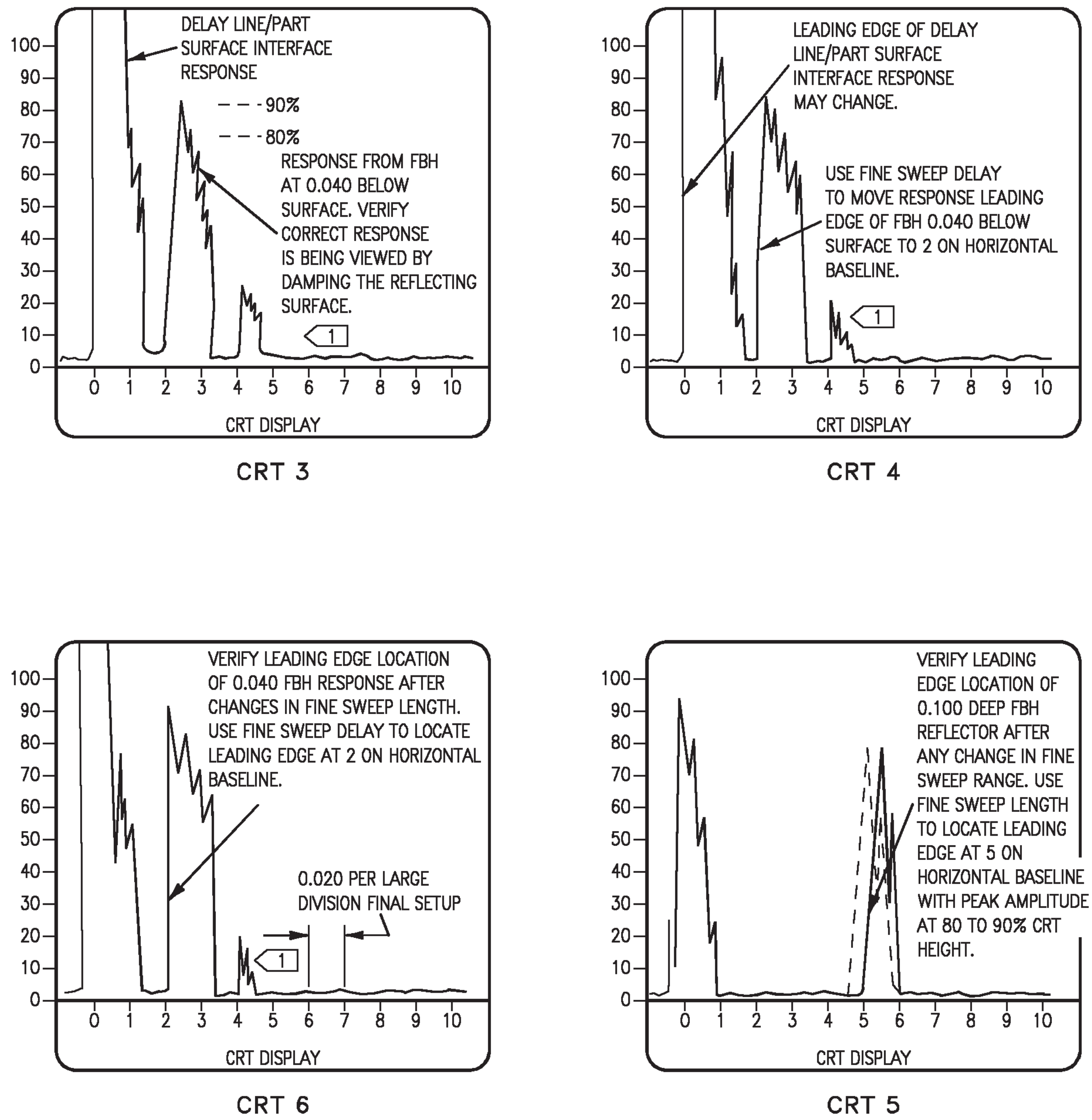


CRT 2

MAJOR CHANGE

18AC-SRM-30-(66-1)34-SCAN

Figure 3. Composite Setup for 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit (Sheet 1)



LEGEND

1 MULTIPLE MAY OR MAY NOT APPEAR

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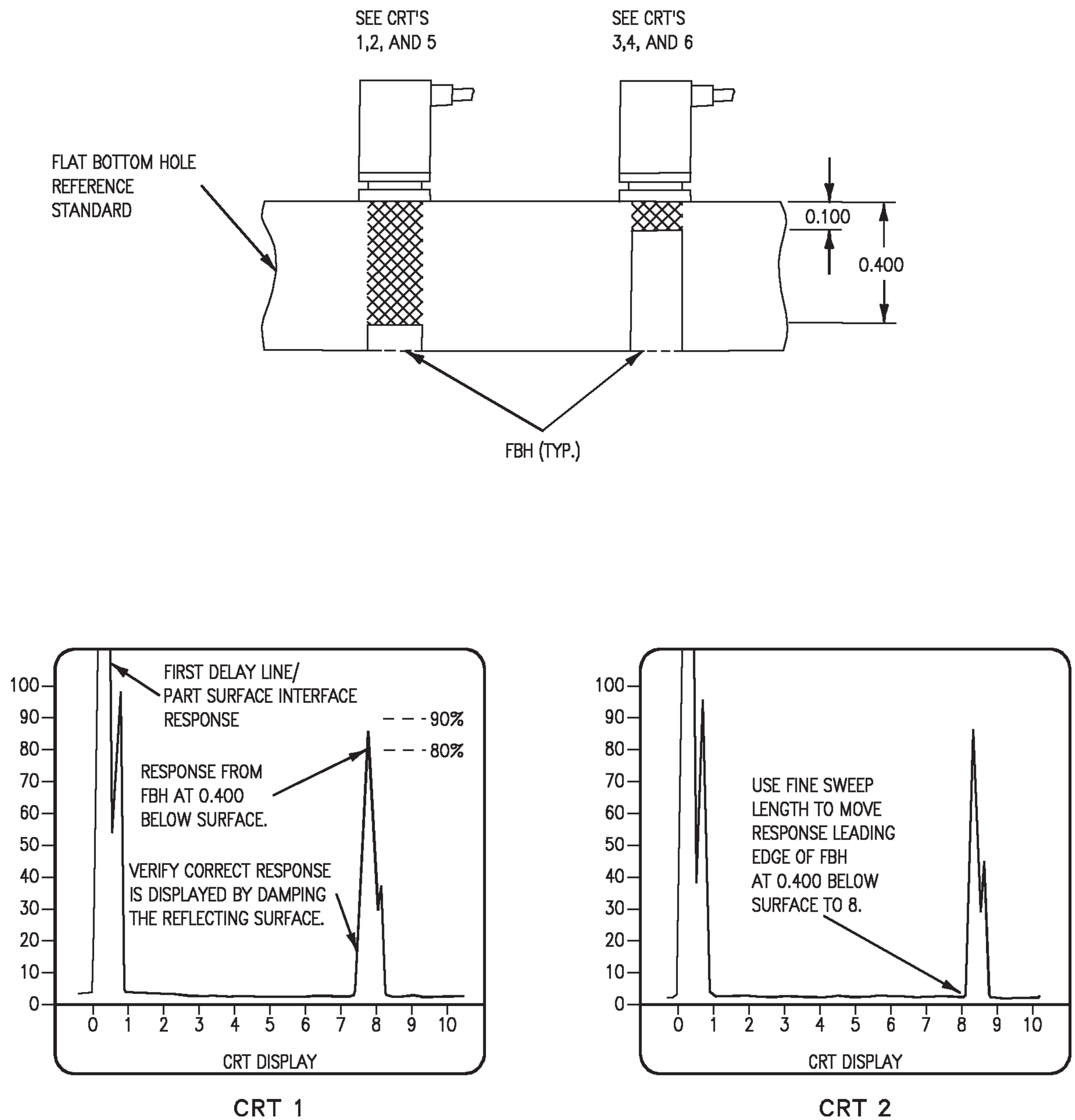
18AC-SRM-30-(66-2)34-SCAN

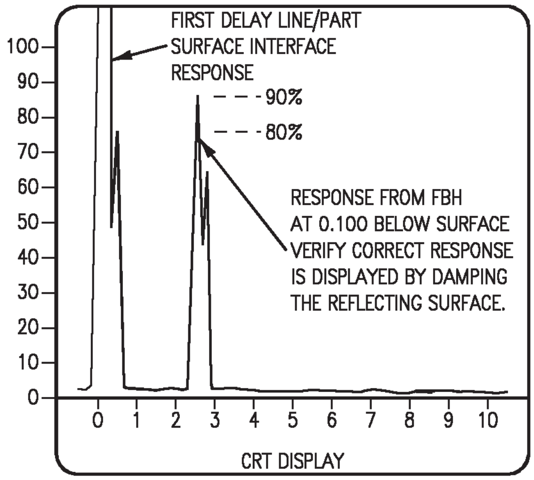
Figure 3. Composite Setup for 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit (Sheet 2)



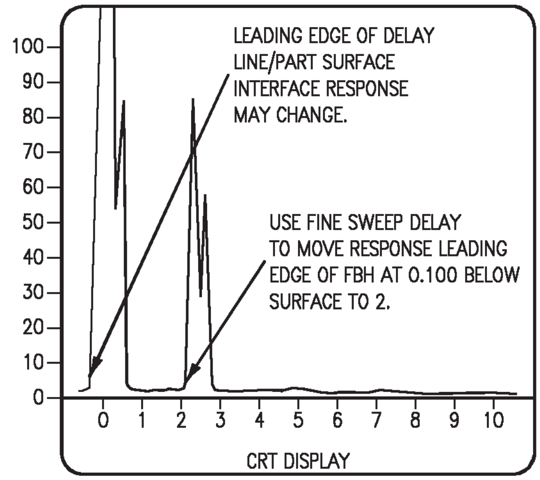
MAJOR CHANGE

18AC-SRM-30-(69-1)34-SCAN

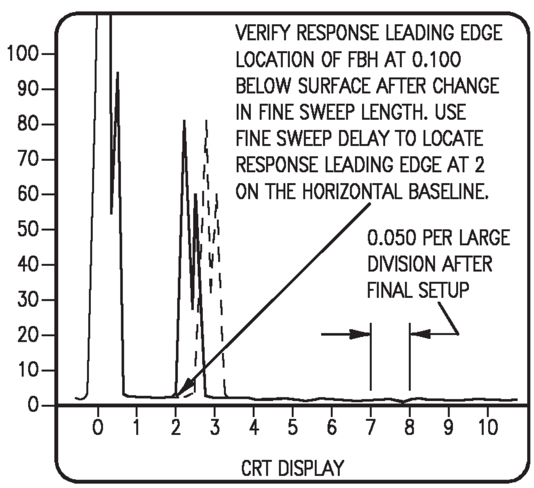
Figure 4. Composite Setup for 0.450 Inch Thick Laminate Material Using Delay Line Search Unit (Sheet 1)



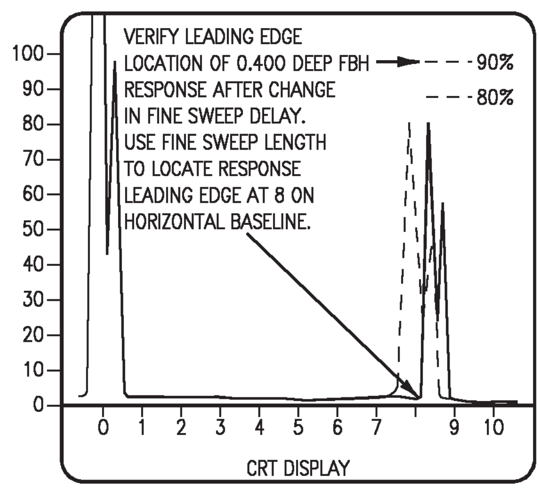
CRT 3



CRT 4



CRT 6

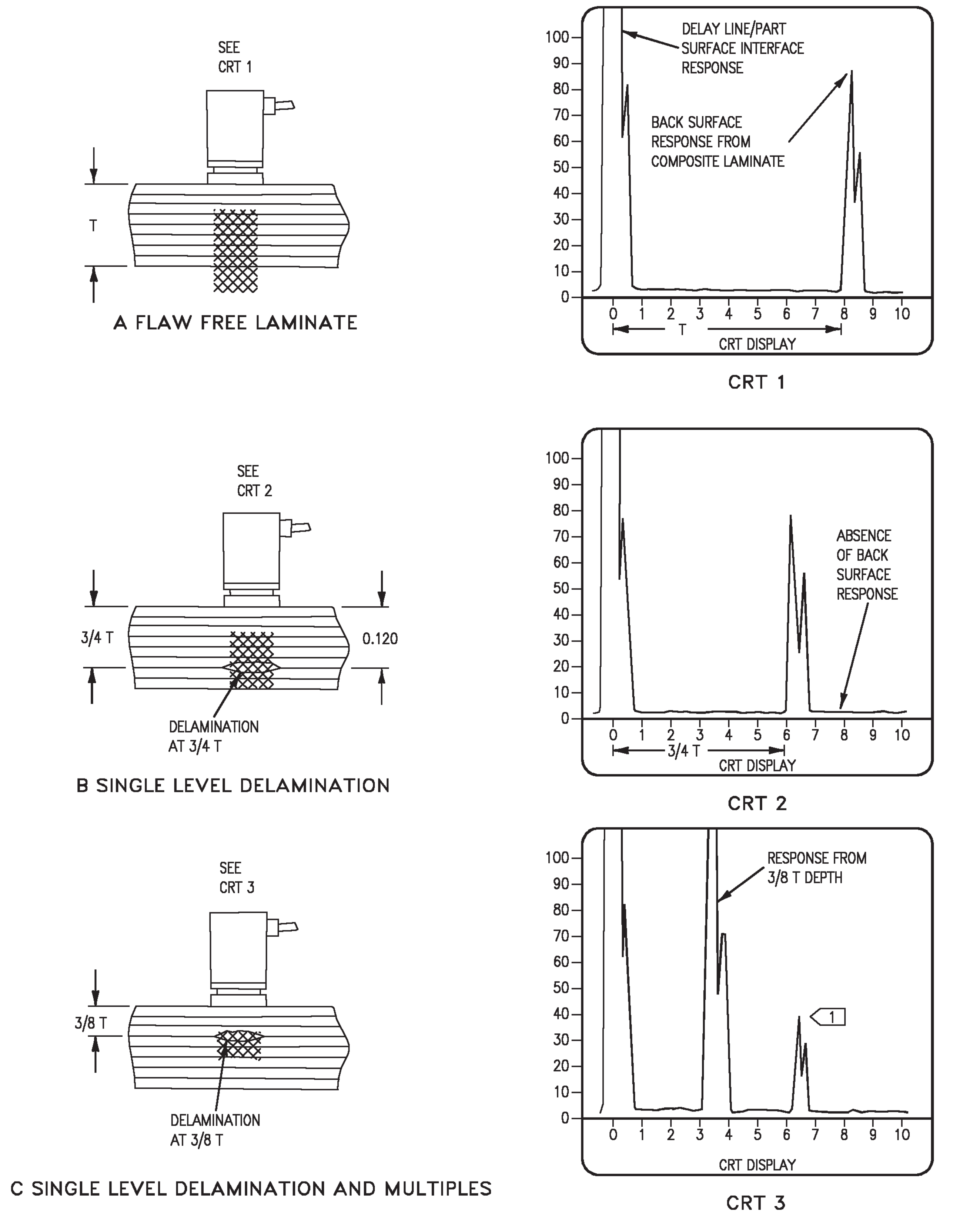


CRT 5

MAJOR CHANGE

18AC-SRM-30-(69-2)34-SCAN

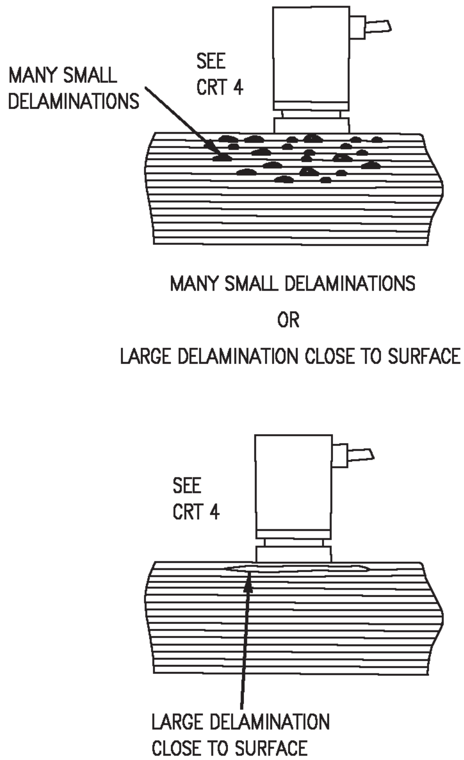
Figure 4. Composite Setup for 0.450 Inch Thick Laminate Material Using Delay Line Search Unit (Sheet 2)



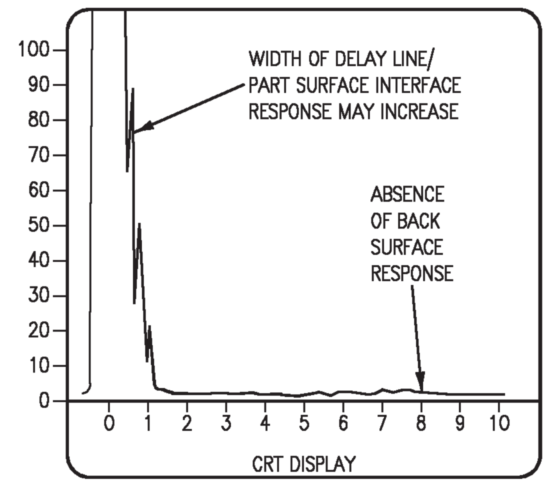
MAJOR CHANGE

18AC-SRM-30-(71-1)34-SCAN

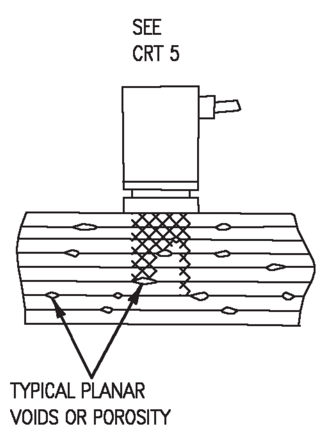
Figure 5. Typical Composite Laminate Inspection (Sheet 1)



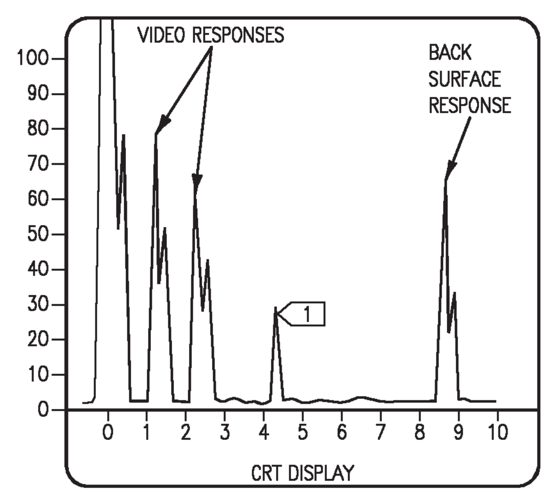
D SMALL DELAMINATIONS OR LARGE NEAR SURFACE DELAMINATION



CRT 4



E PLANAR VOIDS OR POROSITY

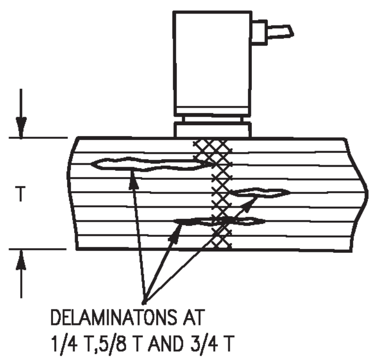


CRT 5

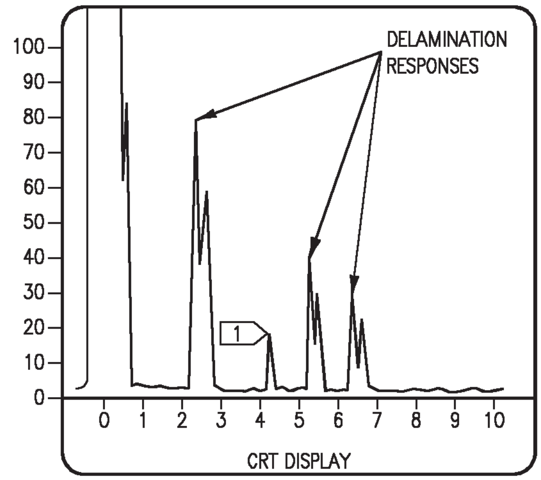
MAJOR CHANGE

18AC-SRM-30-(71-2)34-SCAN

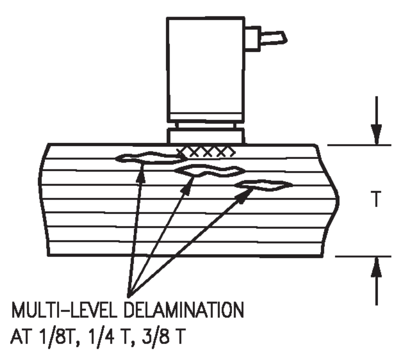
Figure 5. Typical Composite Laminate Inspection (Sheet 2)



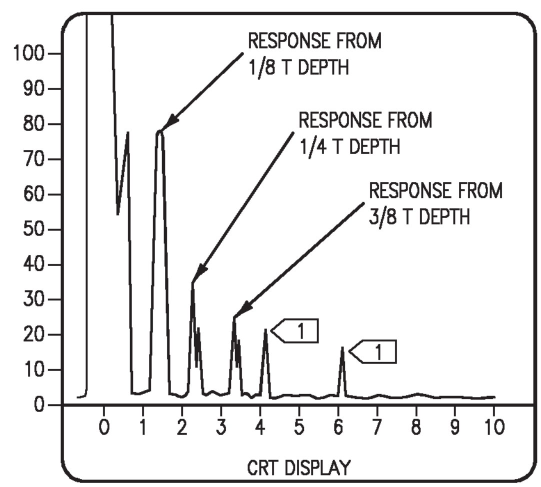
F MULTIPLE LEVEL DELAMINATION



CRT 6



G MULTIPLE LEVEL DELAMINATION
AND MULTIPLES

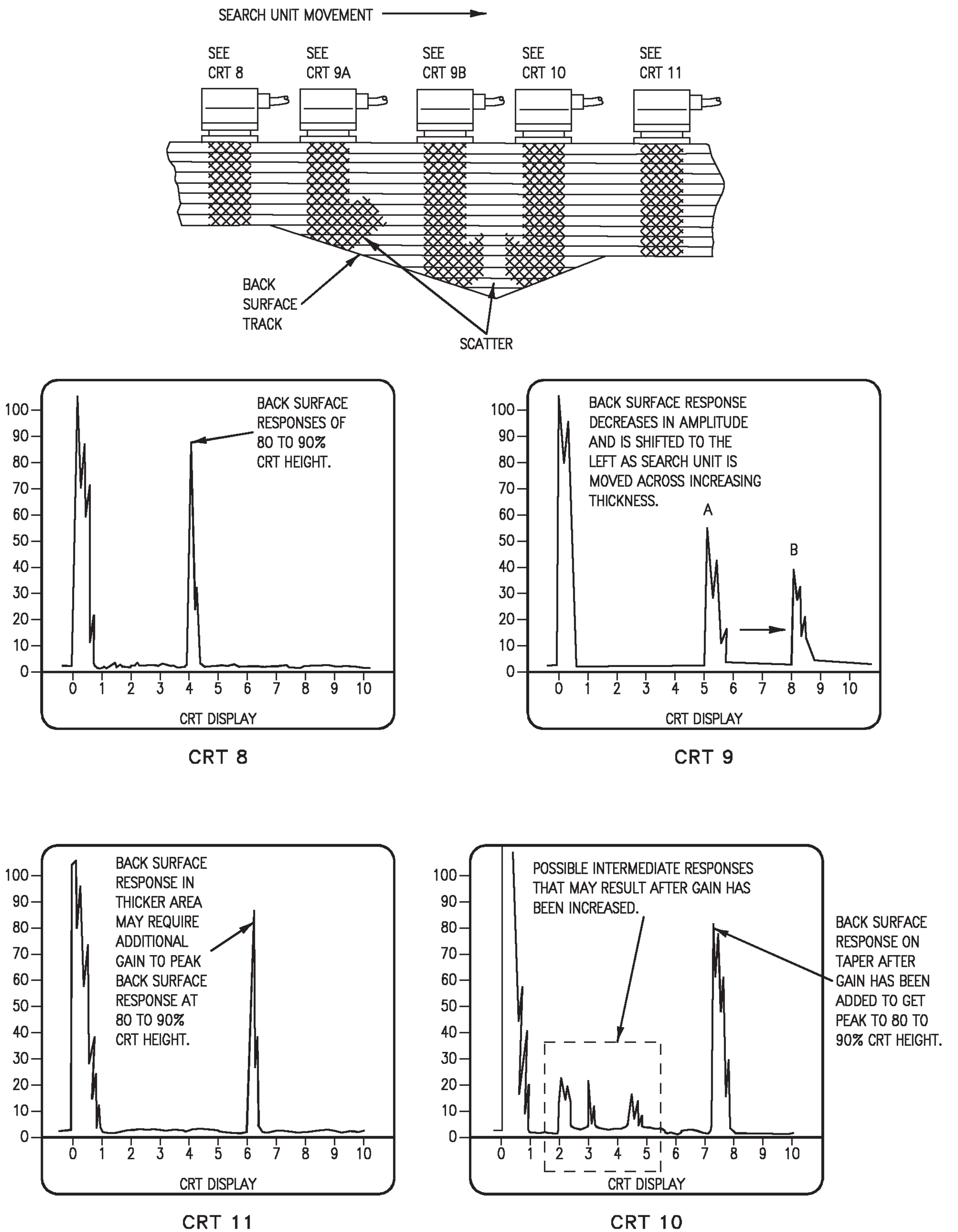


CRT 7

MAJOR CHANGE

18AC-SRM-30-(71-3)34-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 3)

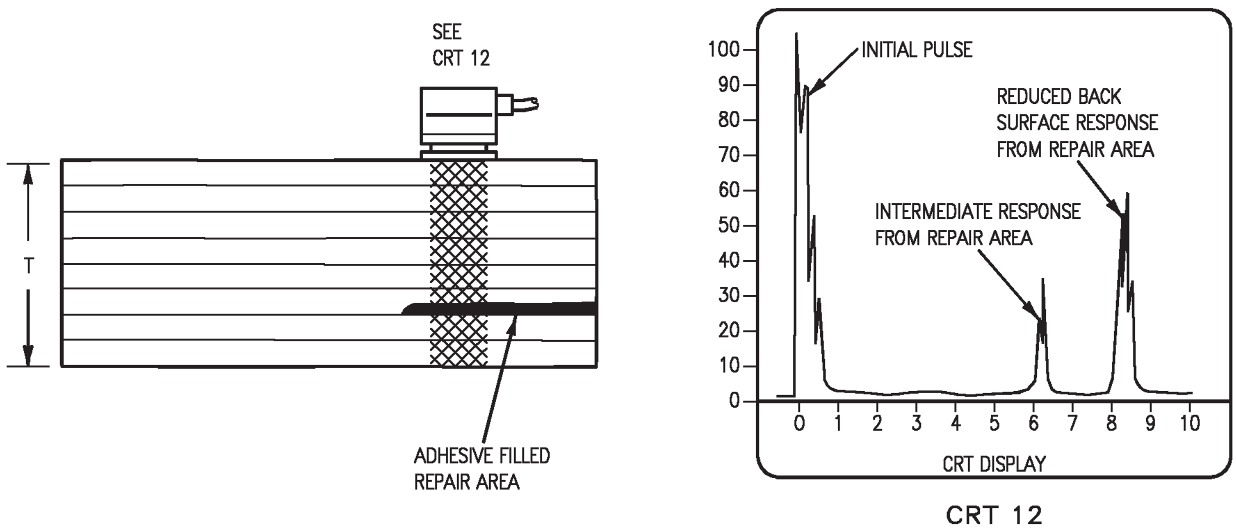


MAJOR CHANGE

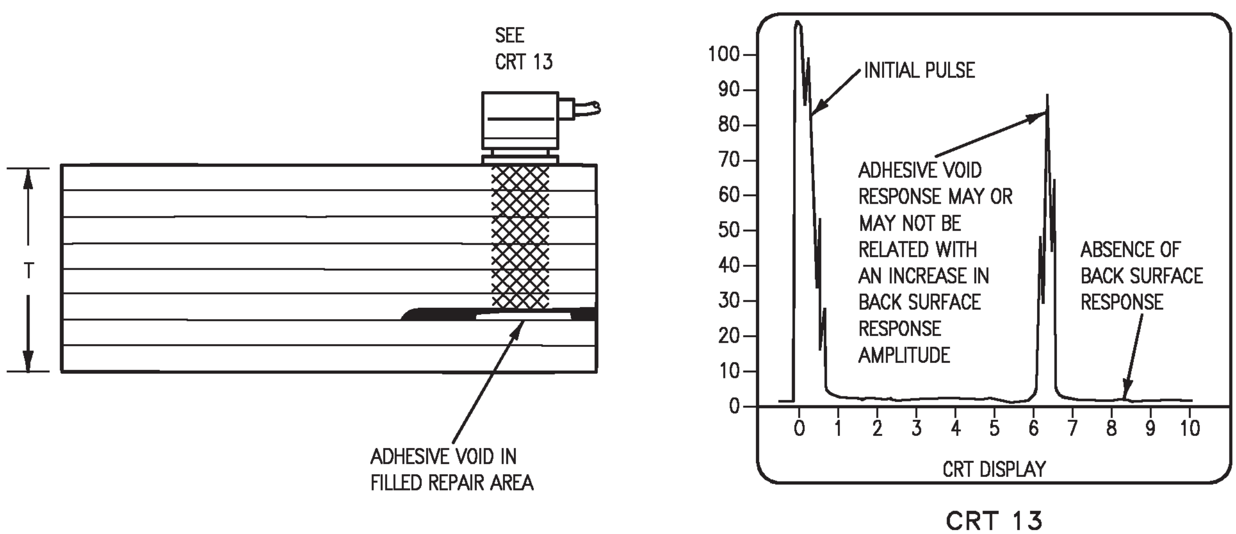
H SEARCH UNIT MOVEMENT ACROSS TAPER

18AC-SRM-30-(71-4)34-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 4)



I ADHESIVE FILLED REPAIR AREA



J ADHESIVE VOID IN FILLED REPAIR AREA

18AC-SRM-30-(71-5)34-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 5)

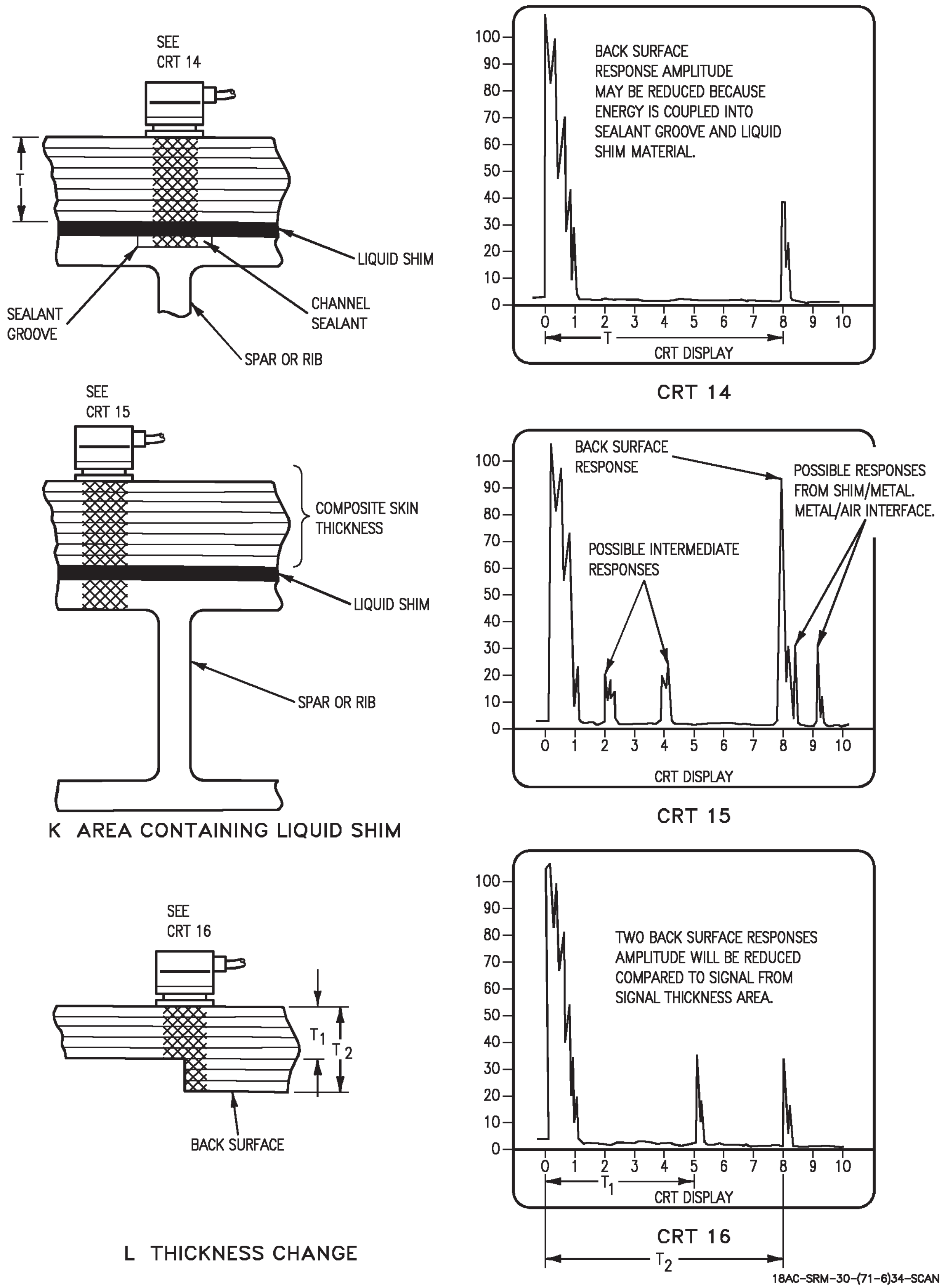
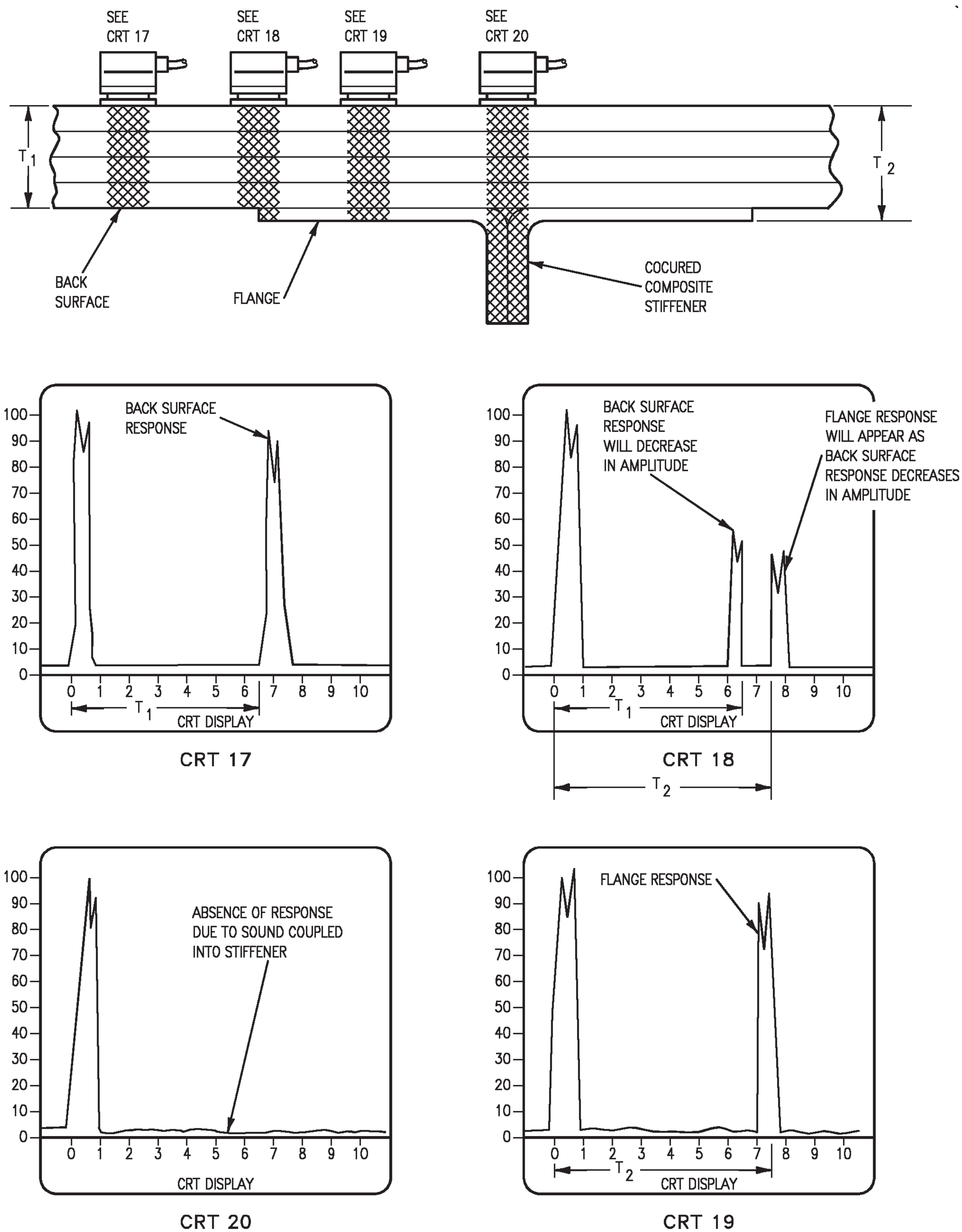


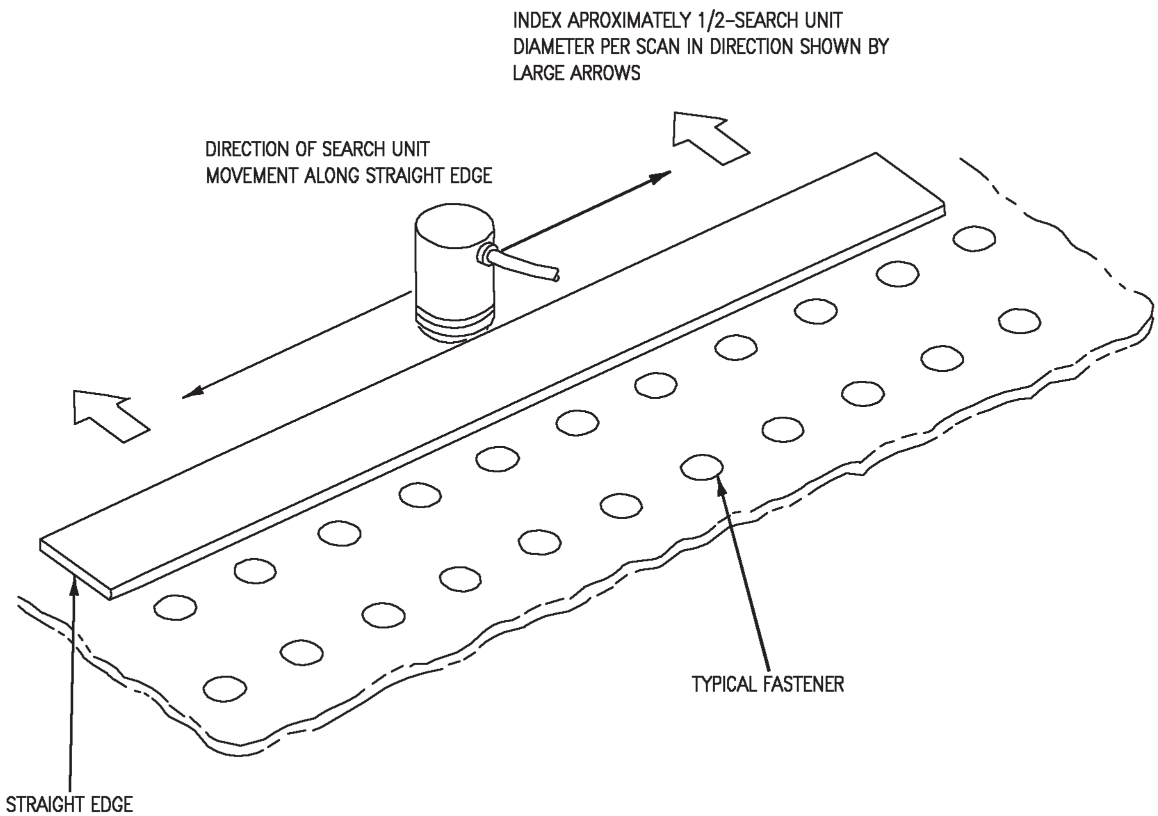
Figure 5. Typical Composite Laminate Inspection (Sheet 6)



M COCURED COMPOSITE STIFFENER

18AC-SRM-30-(71-7)34-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 7)



18AC-SRM-30-(73-1)21-SCAN

Figure 6. Scanning With Straight Edge Assist

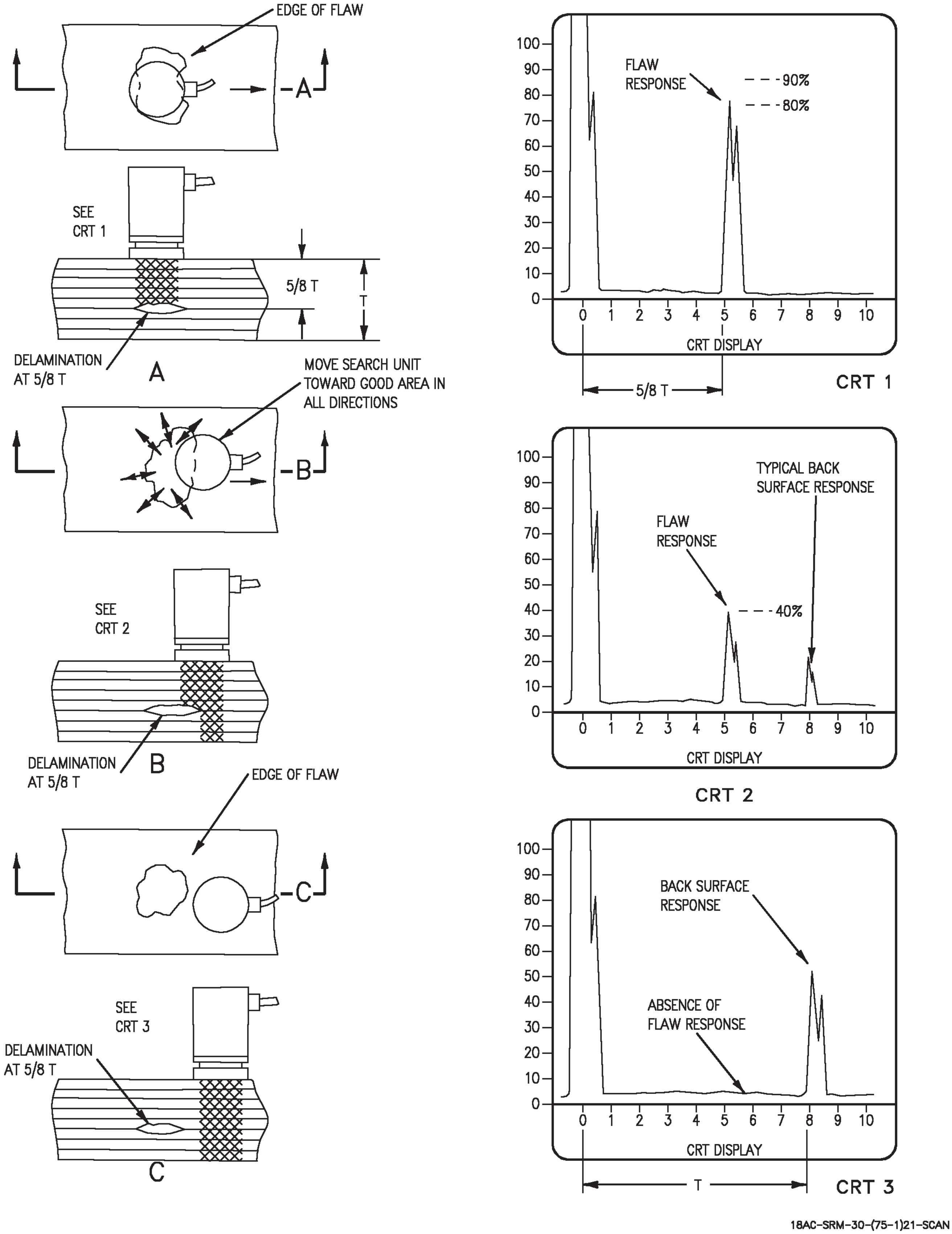


Figure 7. Half Amplitude Mapping Using Delay Line Search Unit Setup

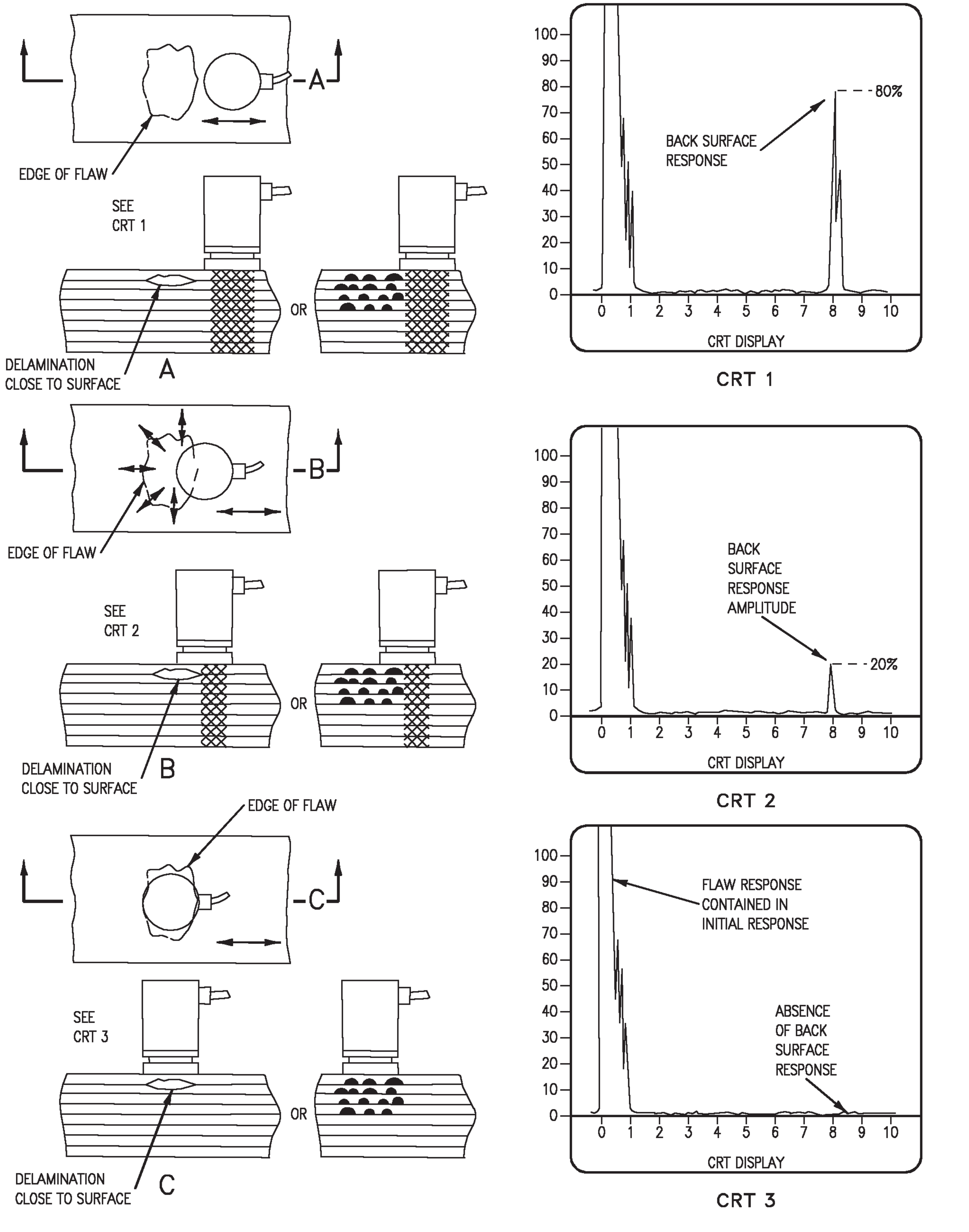


Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations

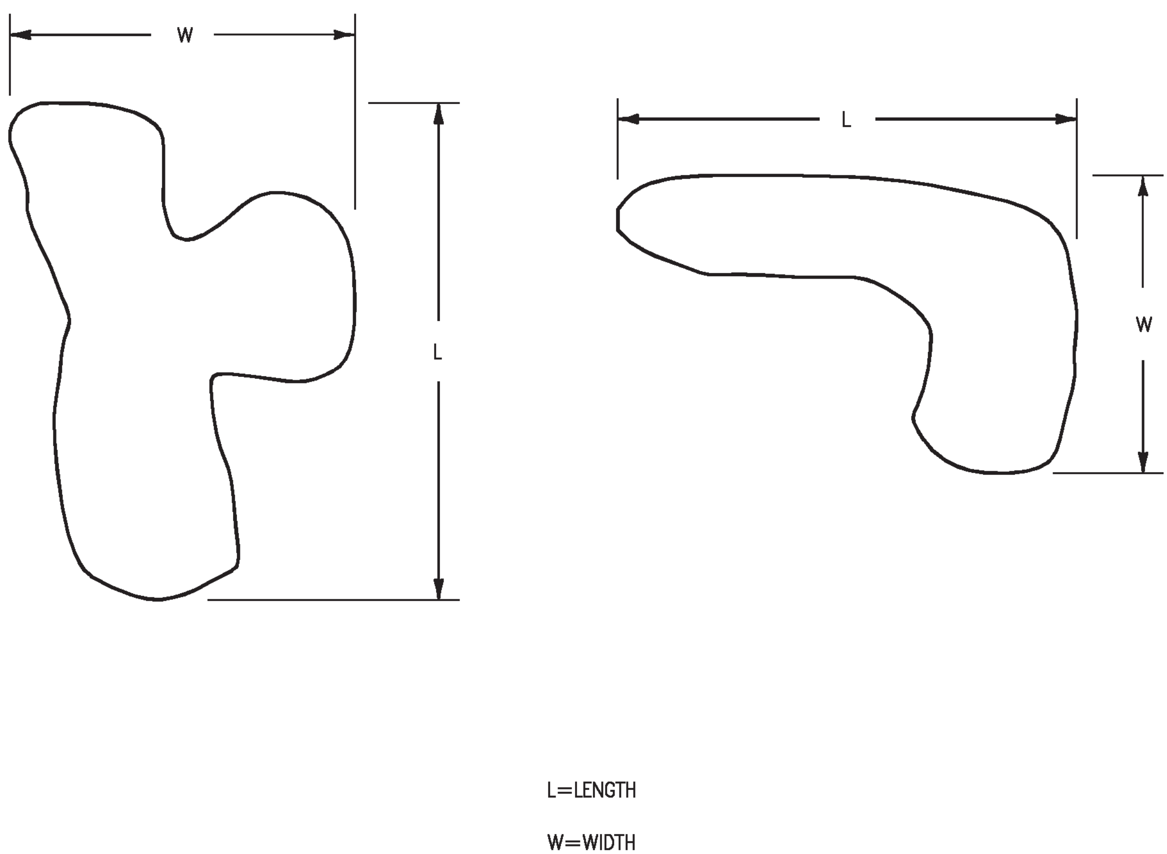


Figure 9. Half Amplitude Mapping

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE - ECHO, LONGITUDINAL WAVE CONTACT, WITH DELAY LINE, FOR COMPOSITE LAMINATE MATERIAL BONDED TO HONEYCOMB CORE

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed longitudinal waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is then used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Delay line is used as standoff and often improves near surface resolution.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 Series, NDI Technicians,

NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
C-398	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Delay Line Search Units
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect search unit to Microdot cable.

b. Connect BNC end of microdot cable to T or R BNC jacks on tester.

c. Turn tester ON. Allow 15 minutes warm-up.

d. Set tester front face settings:

NOTE

Equipment differences may require use of alternate COARSE SWEEP RANGE, FREQ, REP RATE, FINE SWEEP RANGE, VIDEO DISPLAY, DAMPING and REJECT settings.

COARSE SWEEP RANGE	0.5 INCH
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0-3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE ECHO
FINE GAIN	MAX
REP RATE	AUTO
FINE SWEEP RANGE	MIN
DAMPING	APPROX. MID SCALE
REJECT	APPROX. 0
VIDEO DISPLAY	EITHER +, −, or FULL WAVE

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. First response from delay line/air interface may also be visible.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline.

NOTE

During damping, amplitude of delay line/air interface response should decrease, but initial pulse amplitude should remain constant.

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by setting ATTENUATORS.

h. Adjust FINE SWEEP RANGE, FINE SWEEP DELAY, and GAIN so first delay line/air interface response is visible on CRT horizontal baseline while initial pulse is still visible. Damp end of delay line with finger to get reduction in peak amplitude, and verify correct response is being viewed. See figure 1, CRT 2.

i. After delay line/air interface response has been identified, use FINE SWEEP DELAY to locate this response at zero on CRT horizontal baseline. See figure 1, CRT 3.

NOTE

If second delay line/air interface response is not visible, increase GAIN to see if response appears. If increasing GAIN causes second response to appear, first damp transducer with finger to verify response is second delay line/air interface response and is not noise due to increased gain. Next, adjust FINE SWEEP RANGE to locate second delay line/air response off screen. Return GAIN to previous setting.

j. A second delay line/air interface response may be visible if certain settings have been selected. See figure 1, CRT 3. Second response may be moved off CRT or located beyond 10 on CRT horizontal baseline by adjusting FINE SWEEP RANGE. It is desirable to work in time period between first and second delay line interface responses. See figure 1, CRT 4.

k. After making adjustments to move second delay line/air response off CRT screen, make sure first delay line/air interface response is still located at zero on CRT horizontal baseline. Adjust FINE SWEEP DELAY to relocate response to zero if it is not. See figure 1, CRT 4. Tester is now ready for time-base standardization.

6. **TIME-BASE STANDARDIZATION FOR COMPOSITE LAMINATES UP TO 0.190 INCH THICK.** Time base standardization is required because delamination in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been setup to represent 0.020 of material, unknown response located at 5 large divisions on CRT horizontal baseline represents 0.100 of setup material. Full scale response at 10 on CRT horizontal baseline would be equivalent to 0.200 of composite material after setup. Use flat bottom hole (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 1, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard of Figure 2 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, a number before FBH represents material thickness/depth, inches, above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of the 74D110175-1001 reference standard set, over 0.100 FBH.

c. Position search unit over 0.100 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 3, CRT 1.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

e. Damp bottom, or reflecting surface, of 0.100 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Minimum REJECT is recommended.

f. Use DAMPING, REJECT, and FILTER to optimize response and remove baseline noise. Remove couplant from reflecting surface before continuing.

g. With response peak located at 80 to 90 percent CRT height, use FINE SWEEP RANGE to locate leading edge of 0.100 FBH response at 5 on CRT horizontal baseline. See figure 3, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.040 FBH.

i. Position search unit over 0.040 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back surface response from 0.040 FBH is 80 to 90 percent CRT height. See figure 3, CRT 3. Response multiples may or may not be visible.

k. Damp bottom, or reflecting surface, of 0.040 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent CRT height, use FINE SWEEP DELAY to locate leading edge of 0.040 FBH response at 2 on CRT horizontal baseline. See figure 3, CRT 4.

m. Reposition search unit over 0.100 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position of 0.100 FBH response is still located at 5 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP RANGE to relocate leading edge of 0.100 FBH response at 5 when response peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 5.

n. After any changes in FINE SWEEP RANGE, reposition search unit over 0.040 FBH and adjust GAIN, probably decrease, so 0.040 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use FINE SWEEP DELAY to

relocate 0.040 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times as required. Verify correct leading edge locations of responses from 0.100 and 0.040 FBHs when peak amplitudes are 80 to 90 percent CRT height after any changes in either FINE SWEEP RANGE and FINE SWEEP DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminate materials up to 0.190 in thickness. Each large division on CRT horizontal baseline represents 0.020 inch of material. See figure 3, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth is accurately known. FBH response leading edge location should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.020 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

NOTE

Assemblies with thinner laminates, repeat steps n. and o. using reflecting surfaces from 0.015 or 0.025 and 0.075 deep FBHs. With thinner materials and expanded baseline, new set of horizontal sweep length and delay control settings will be required. Composite material thickness per graticule division will have to be calculated after settings have been established.

r. Tester is now standardized for inspection of composite laminates up to 0.190 thick.

7. **INSPECTION PROCEDURE.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

b. Before beginning inspection, determine locations of ply changes, particularly rapid ply changes, stiffeners, and other items lying beneath surface of inspection area(s). This information should be described in specific procedure work packages. Lay out locations of ply changes, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar overlay. Also include applicable thicknesses of part of areas of part on overlay.

c. To make sure large parts are completely inspected, mark grid pattern(s) on inspection area per specific work package using aircraft marking pencil and straight edge. See figure 5. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 inch grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5 and 6 for composite thickness of part being inspected.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit wear face should be parallel to back surface of laminate. See figure 4, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 4, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 5. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid.

i. Mark all areas where back surface response disappears or is shifted toward initial pulse. Use guidelines given in paragraphs 8 through 12 on CRT interpretation to identify flaws. Make sure of coupling before marking defect. Typical delamination or flaw response characteristics from defects at 1/2-laminate thickness are shown in figure 6.

j. Once flaw has been identified, use pulse-echo mapping technique shown in figure 7 and described in paragraph 13.a. for 1/2-amplitude mapping, and figure 8, paragraph 13. b. for mapping flaws close to surface or small multiple delaminations to determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge.

k. Mark all flaw indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

8. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, and possibly back surface response should be visible on CRT. Back surface response should be located at CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 4, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed inspection, described in paragraph 6.

9. **Single Level Delamination.** Delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 4, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 4, CRT 3.

10. **Small Delaminations and Large Near Surface Delaminations.** Small delaminations throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 4, CRT 4.

NOTE

If it is not clear whether indication is due to near surface delamination or presence of heavy porosity, and back Surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates delamination is present. If small response is detected, it is likely that area contains heavy porosity.

11. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate responses may be due to presence of numerous planar voids and multiples from single planar voids. See figure 4, CRTs 5 and 6.

12. **Adhesive Separated From Back Surface of Laminate.** Increase in response amplitude may indicate that adhesive is separated from back surface of laminate skin. In good area, response from adhesive/air interface may be present to right of laminate/adhesive interface response. If adhesive is unbonded from laminate, this adhesive/air interface response will be absent. See figure 4, CRTS 7 and 8.

13. **MAPPING.**

a. Half amplitude mapping:

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent of CRT height. See figure 7, CRT 1.

(3) Move search unit toward good area in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2 amplitude. See figure 7, CRT's 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping For Flaws Close to Surface or Small Multiple Delaminations:

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 8, CRT 1.

(3) Move search unit toward flaw in all directions. Use aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent CRT height. See figure 8, CRT's 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 9.

14. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part. Horizontal baseline location of response leading edge or by using delay line technique when defect is close to surface.

NOTE

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

15. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.

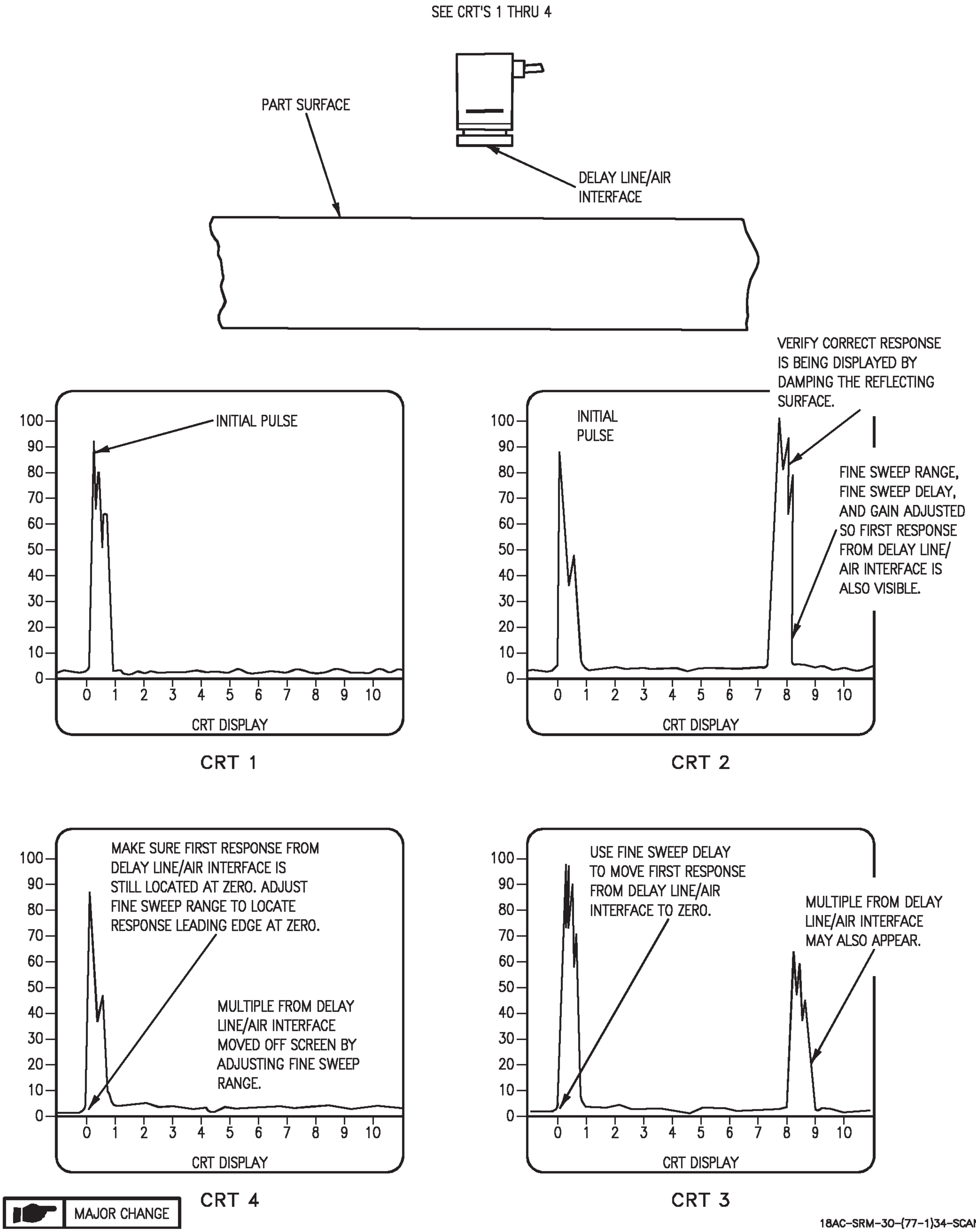


Figure 1. Initial Setup 0.190 Inch Composite Laminate Material With Delay Line Search Unit

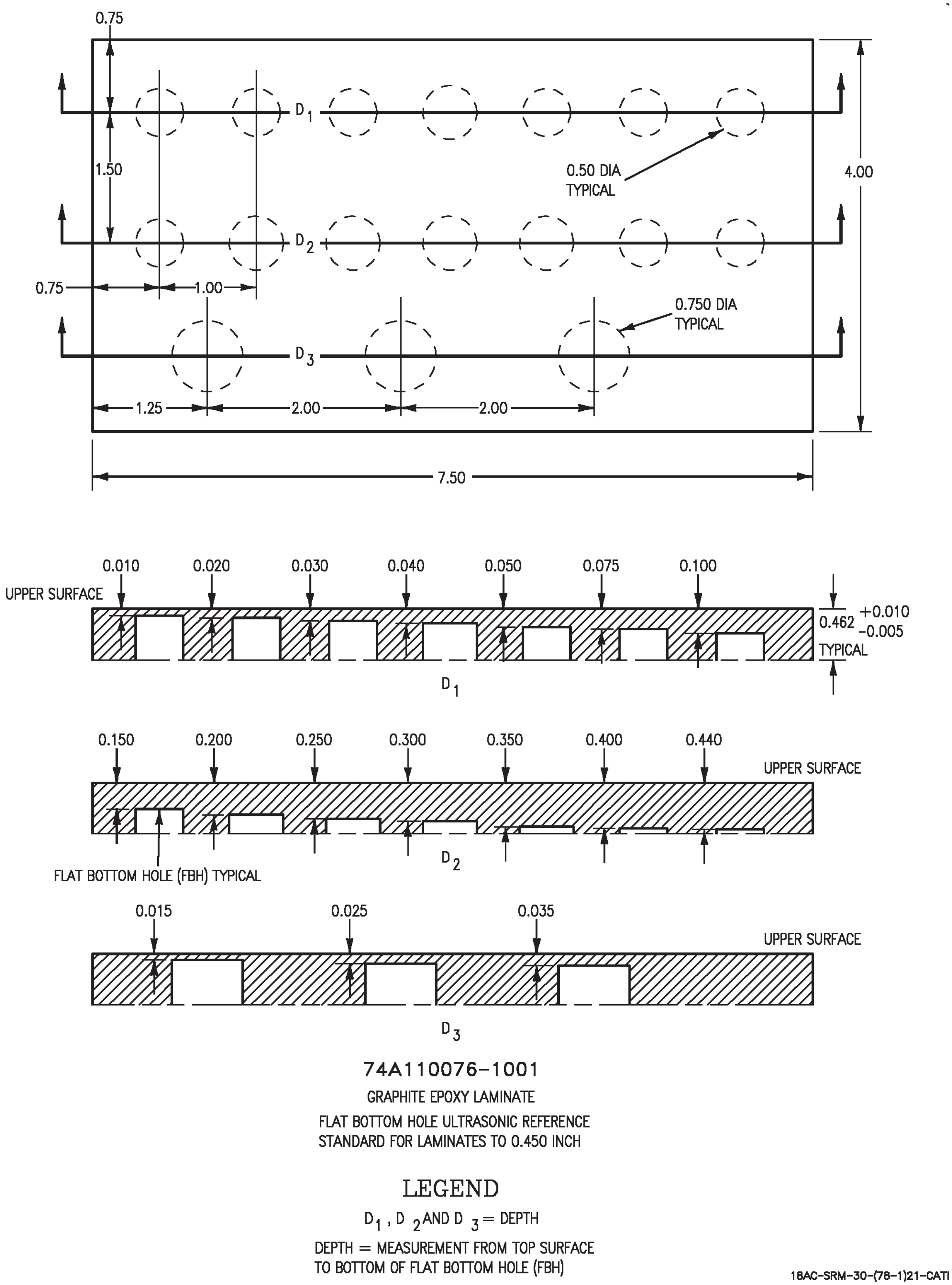
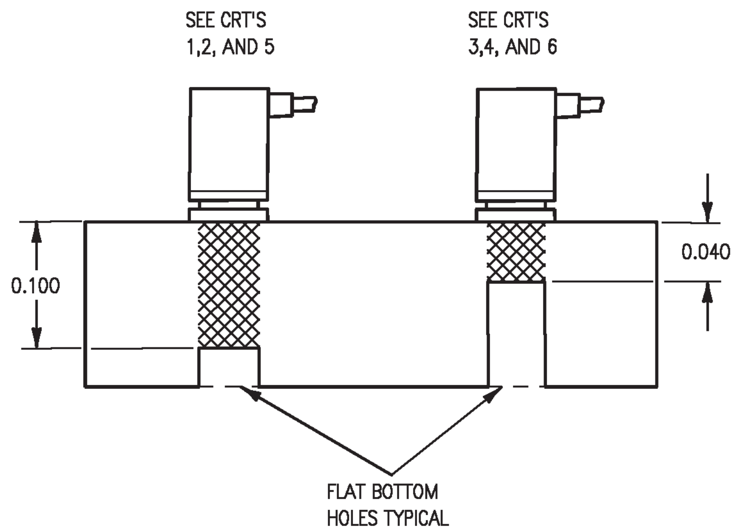
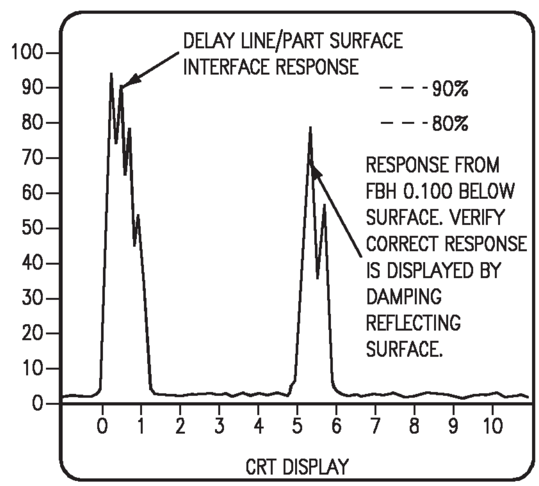
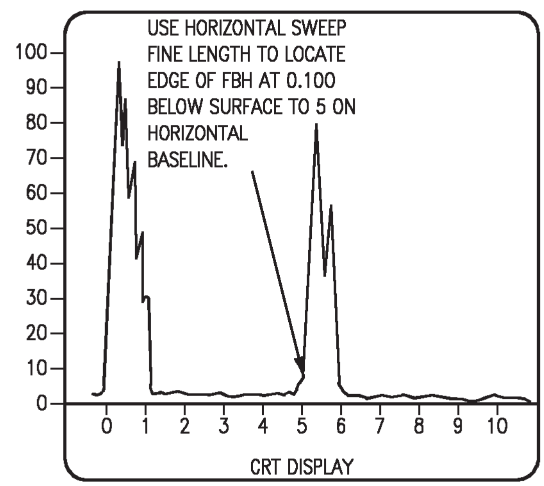


Figure 2. FBH Reference Standard for Delay Line Setup





CRT 1

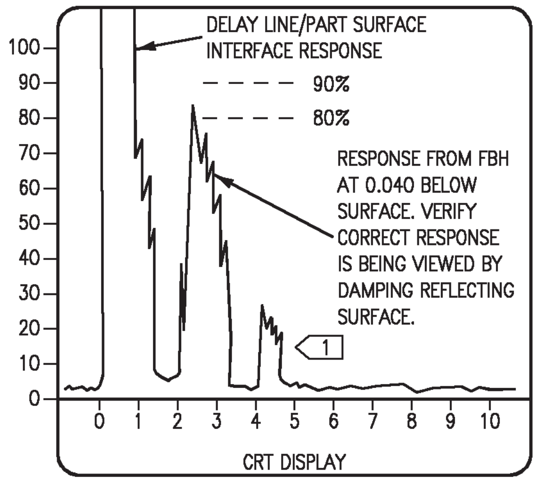


CRT 2

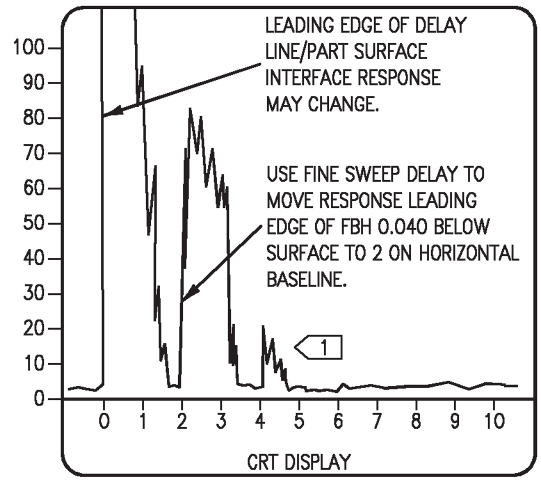
MAJOR CHANGE

18AC-SRM-30-(80-1)34-SCAN

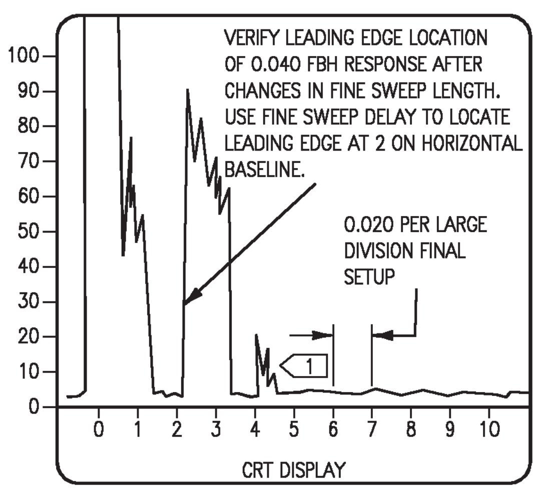
Figure 3. Composite Setup for 0.190 Composite Laminate Material Delay Line Search Unit (Sheet 1)



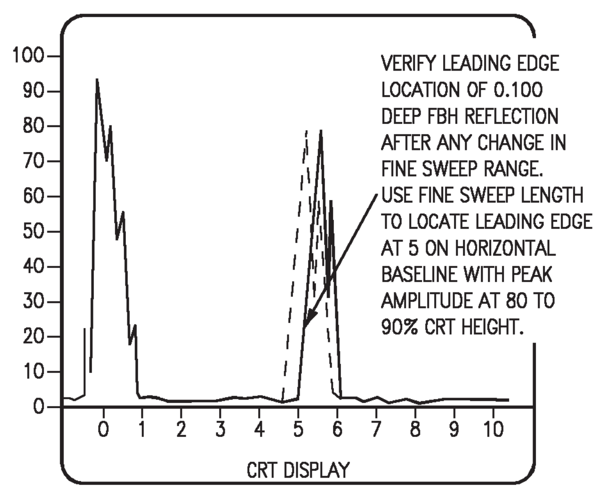
CRT 3



CRT 4



CRT 6



CRT 5

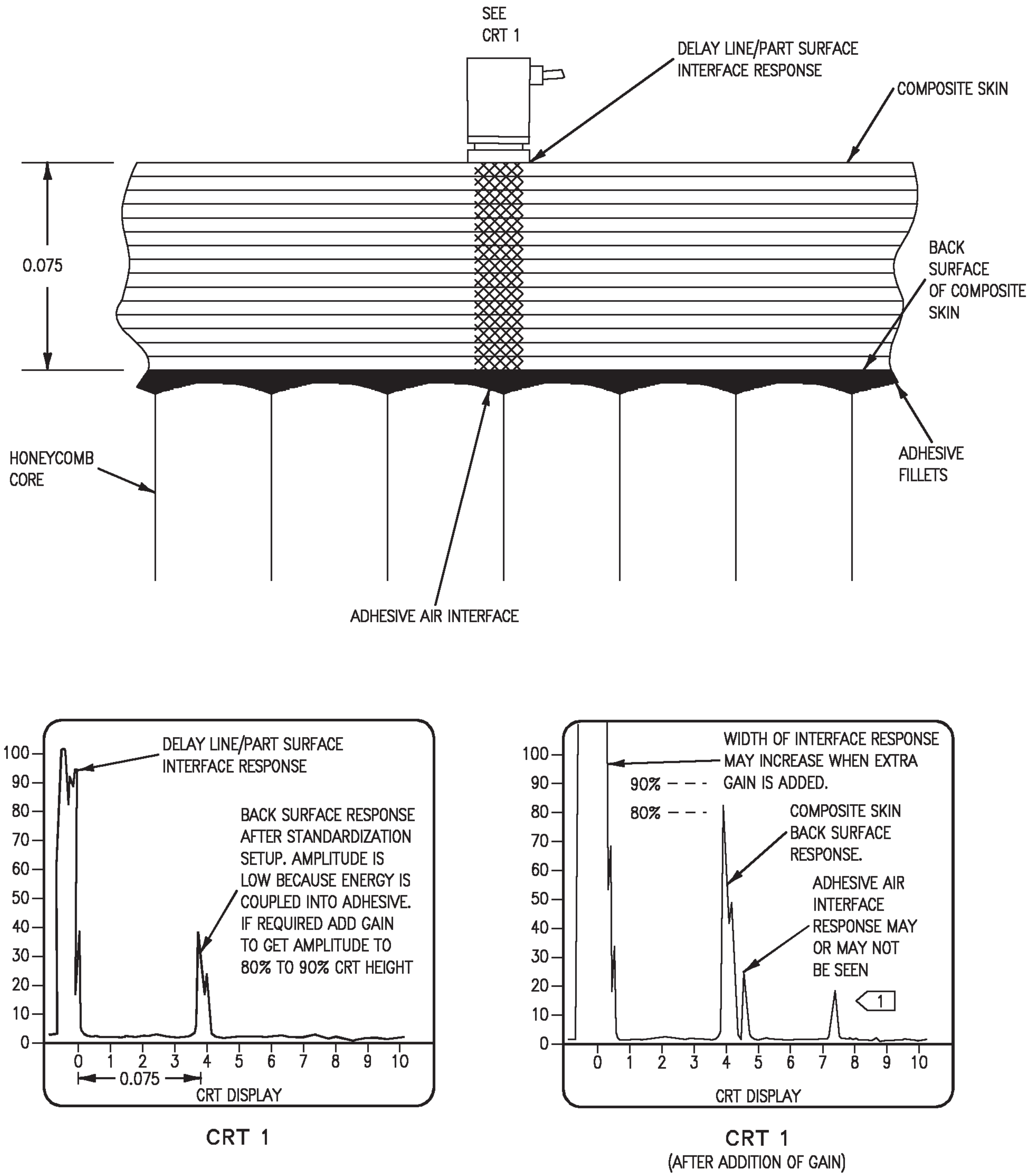
LEGEND

1 MULTIPLE MAY OR MAY NOT APPEAR.

MAJOR CHANGE

18AC-SRM-30-(80-2)34-SCAN

Figure 3. Composite Setup for 0.190 Composite Laminate Material Delay Line Search Unit (Sheet 2)



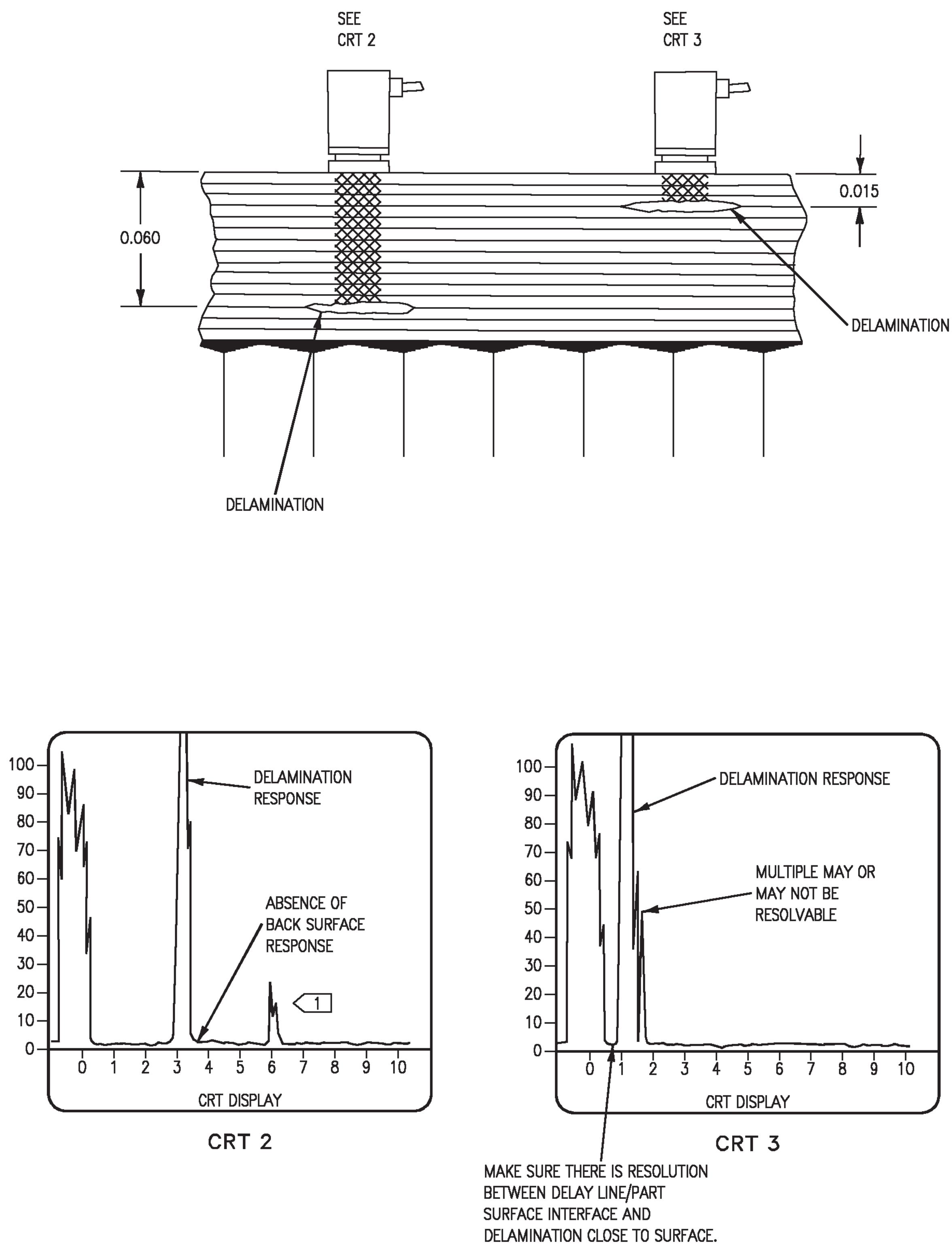
LEGEND

1 MULTIPLES MAY OR MAY NOT BE SEEN

MAJOR CHANGE

18AC-SRM-30-(82-1)34-SCAN

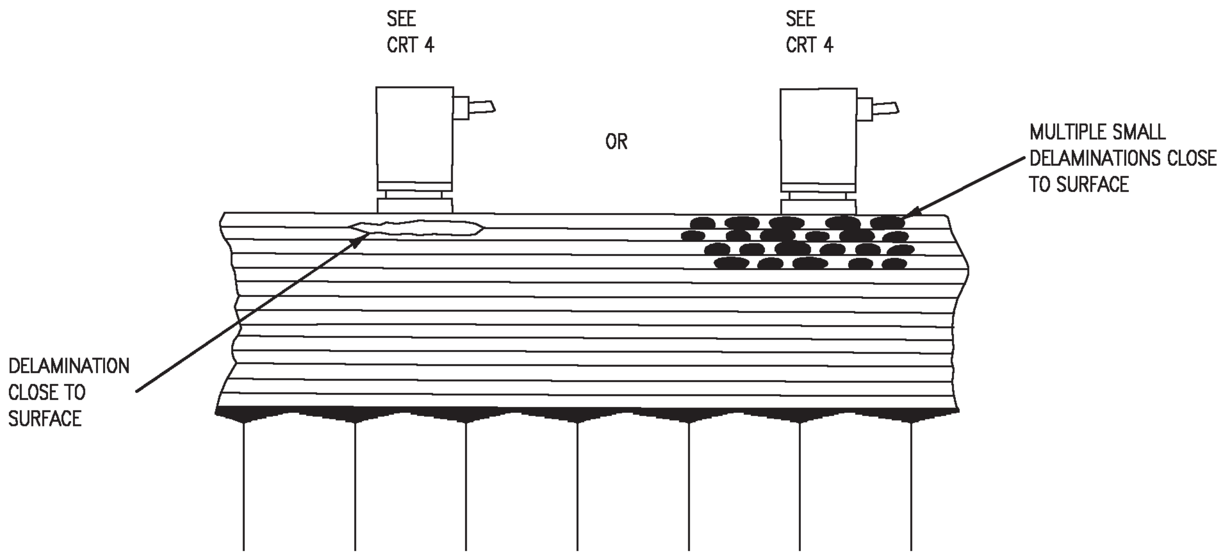
Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 1)

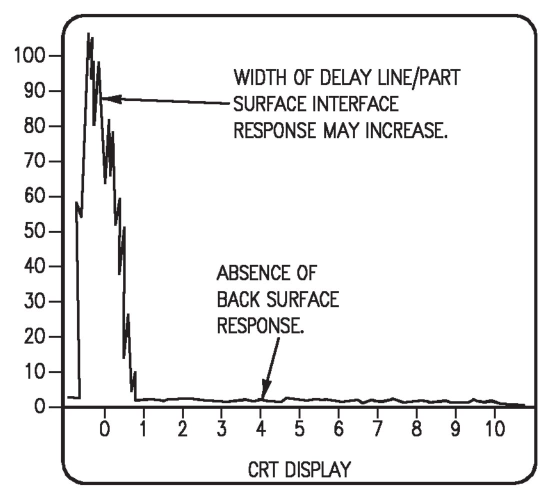


MAJOR CHANGE

18AC-SRM-30-(82-2)34-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 2)



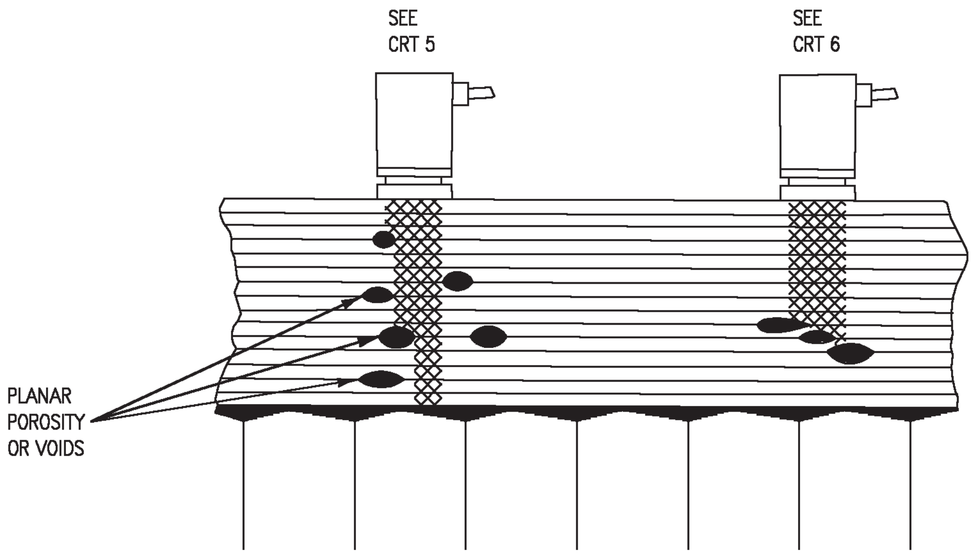


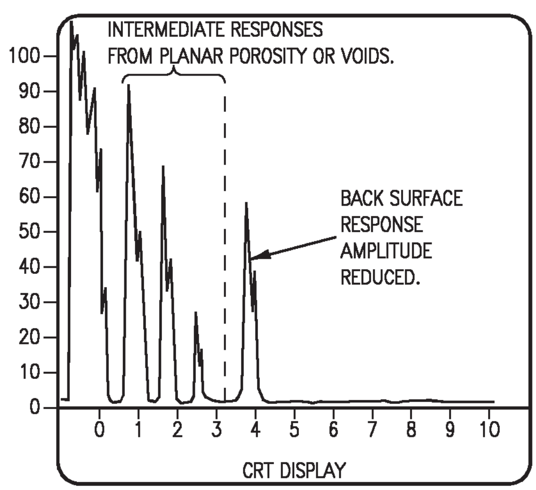
CRT 4

MAJOR CHANGE

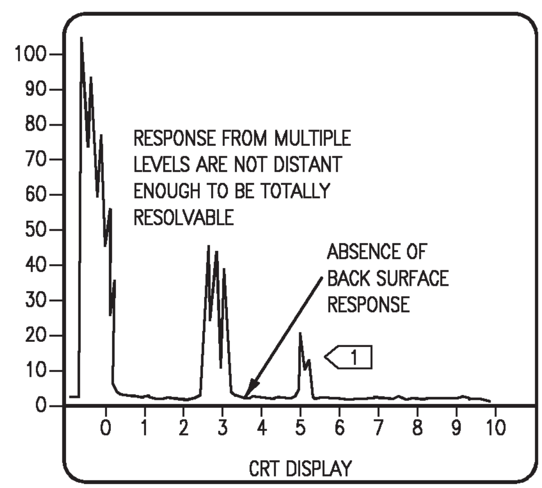
18AC-SRM-30-(82-3)34-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 3)





CRT 5

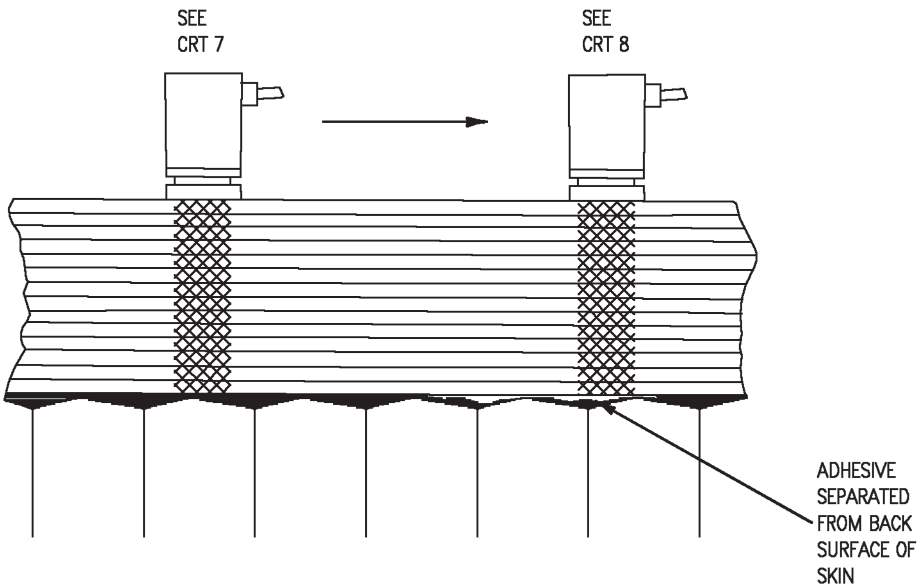


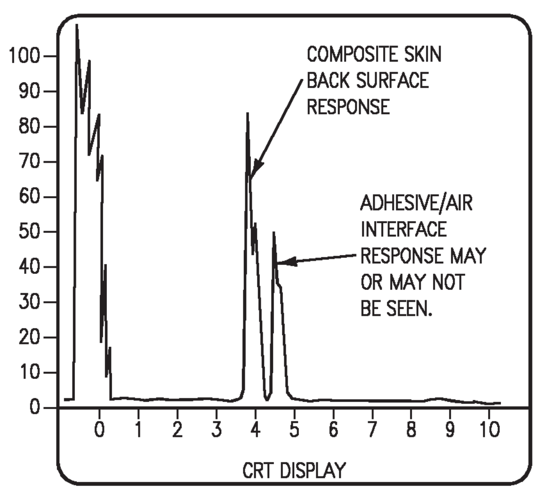
CRT 6

MAJOR CHANGE

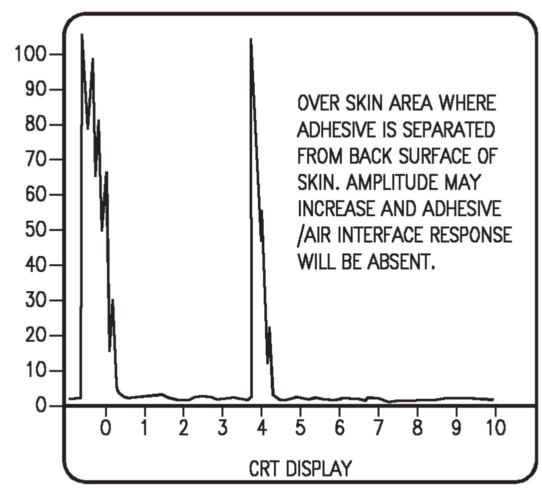
18AC-SRM-30-(82-4)34-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 4)





CRT 7



CRT 8

MAJOR CHANGE

18AC-SRM-30-(82-5)34-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 5)

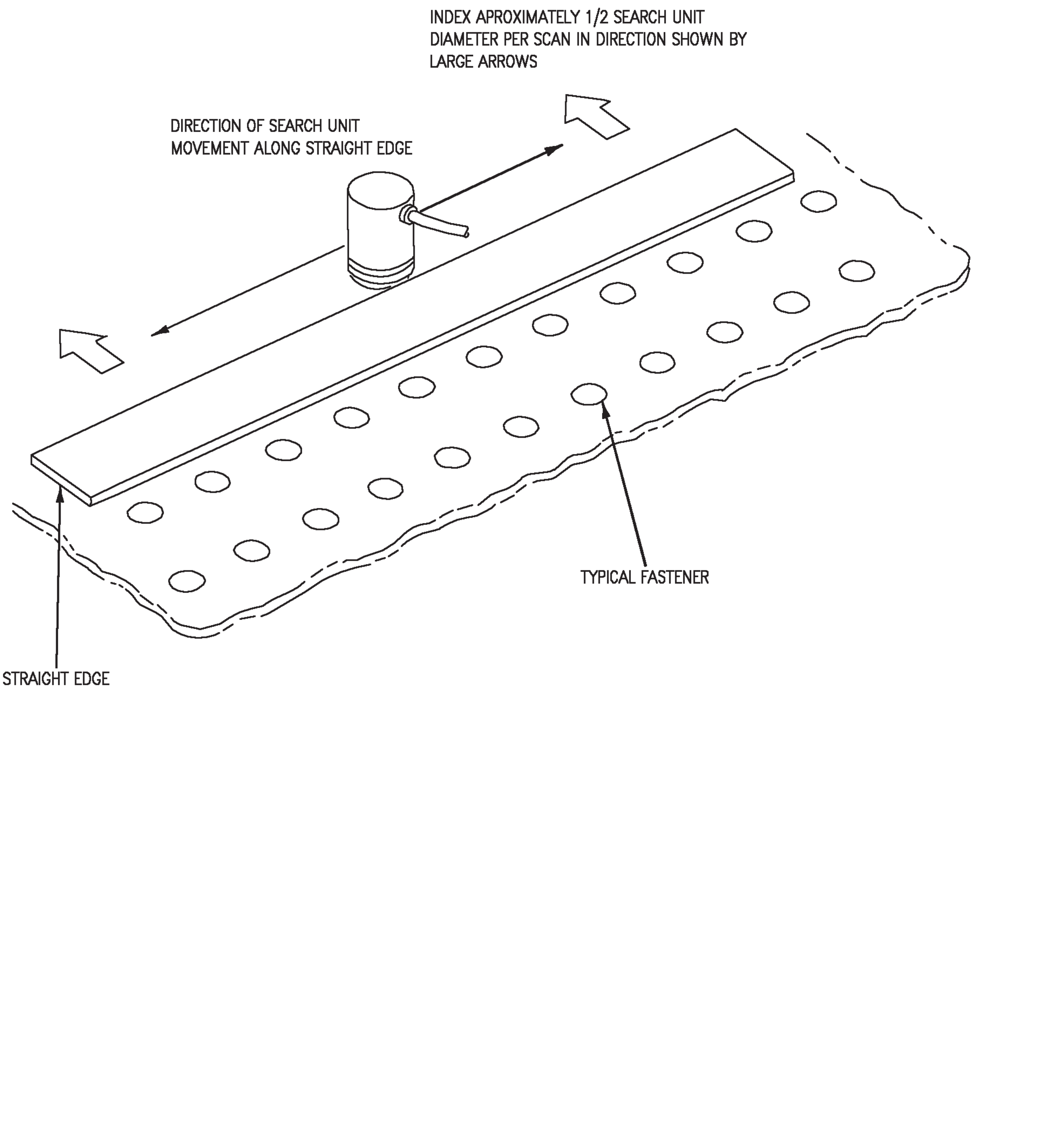
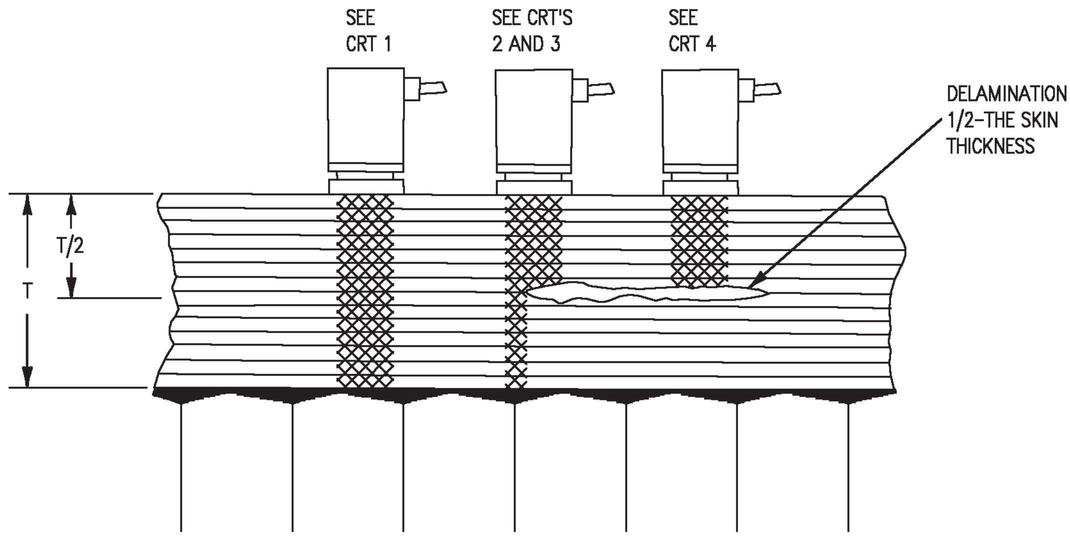
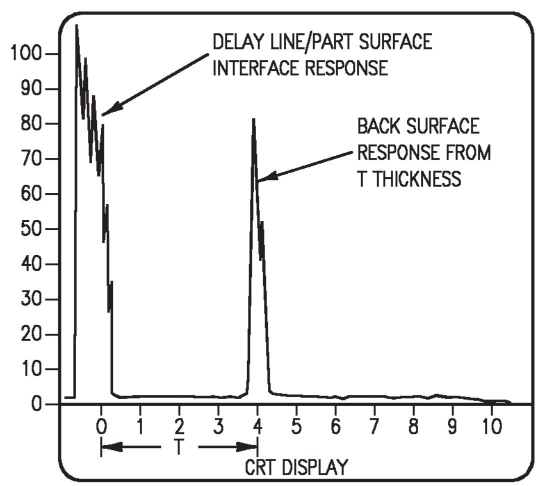
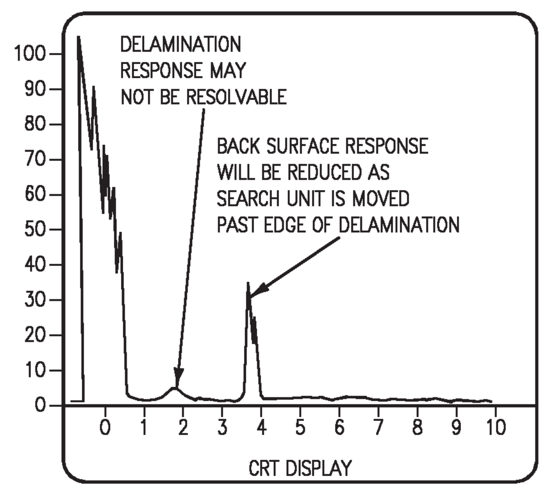


Figure 5. Scanning With Straight Edge





CRT 1

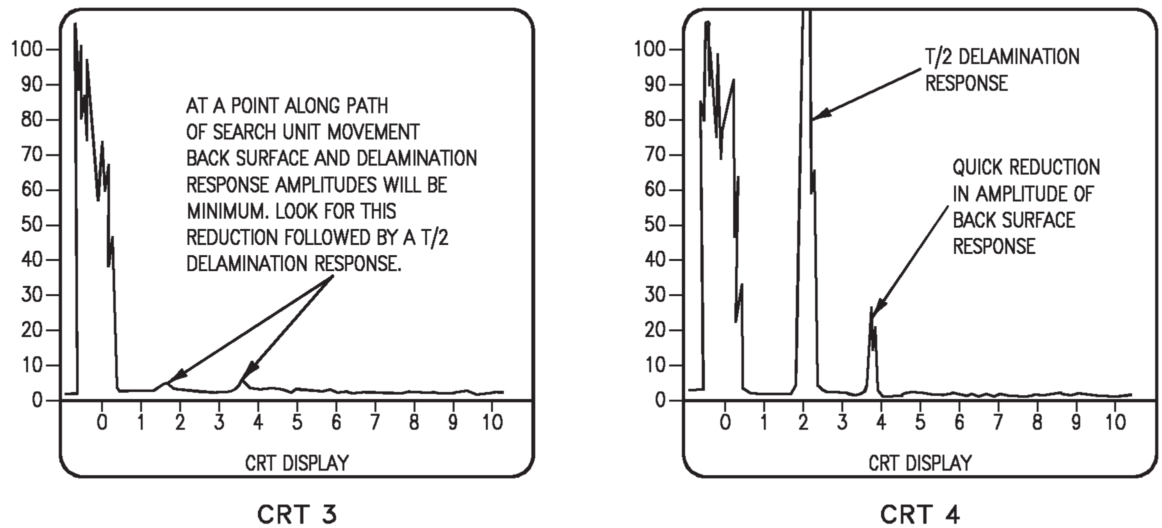


CRT 2

MAJOR CHANGE

18AC-SRM-30-(84-1)34-SCAN

Figure 6. Flaws Located at One Half the Composite Skin Thickness (Sheet 1)



MAJOR CHANGE

18AC-SRM-30-(84-2)34-SCAN

Figure 6. Flaws Located at One Half the Composite Skin Thickness (Sheet 2)

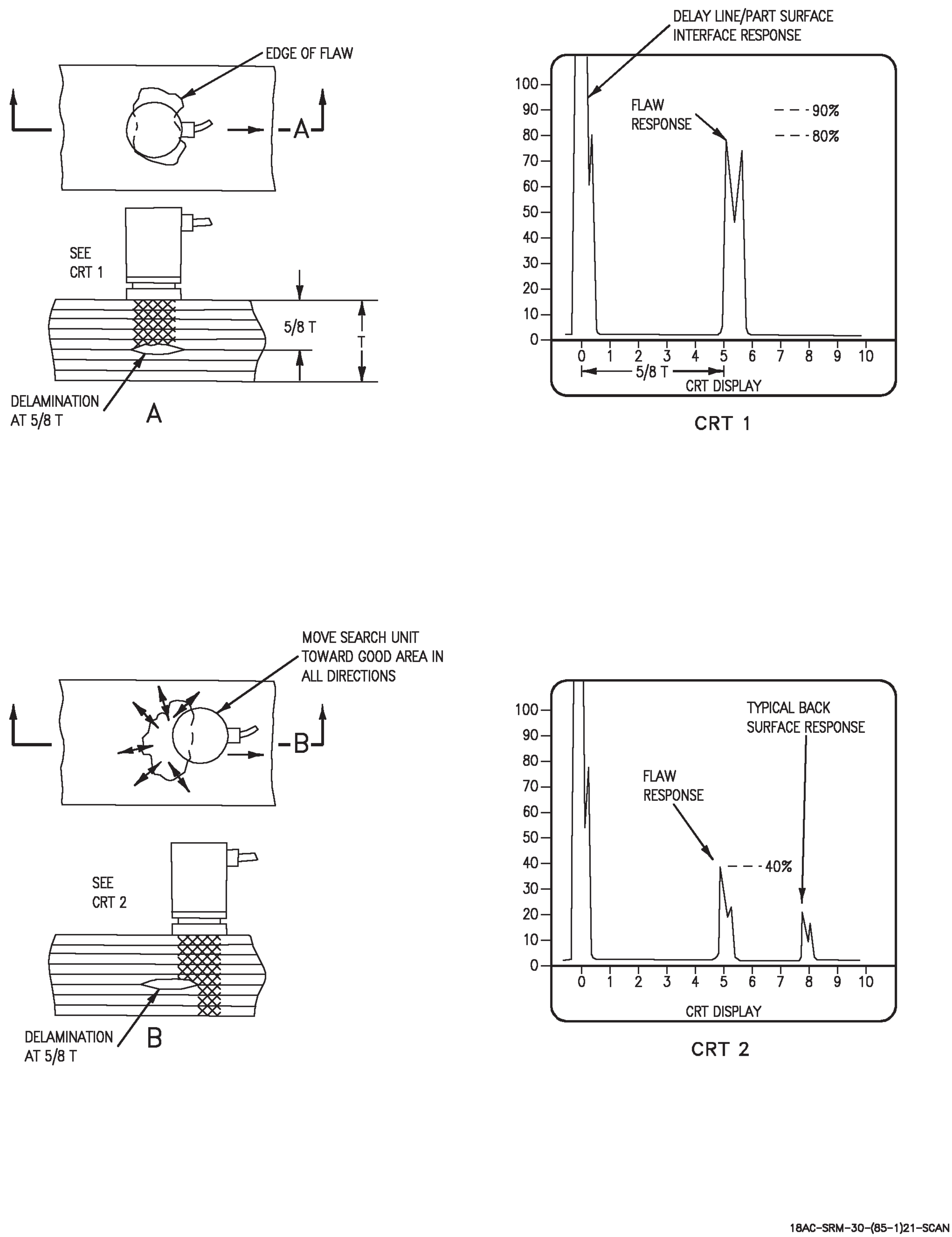
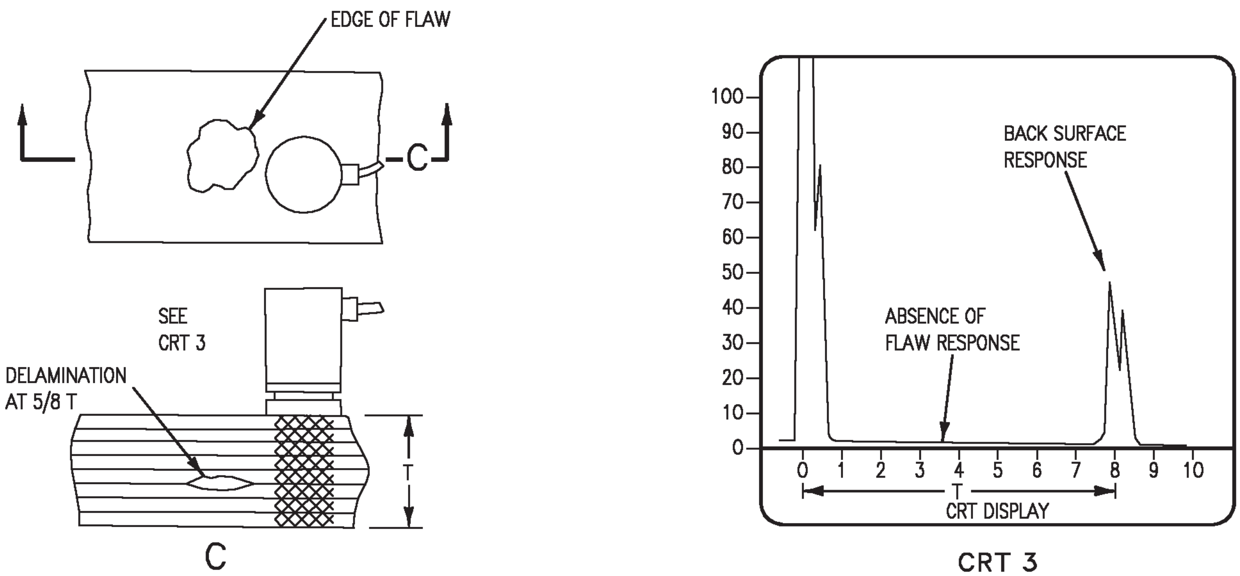
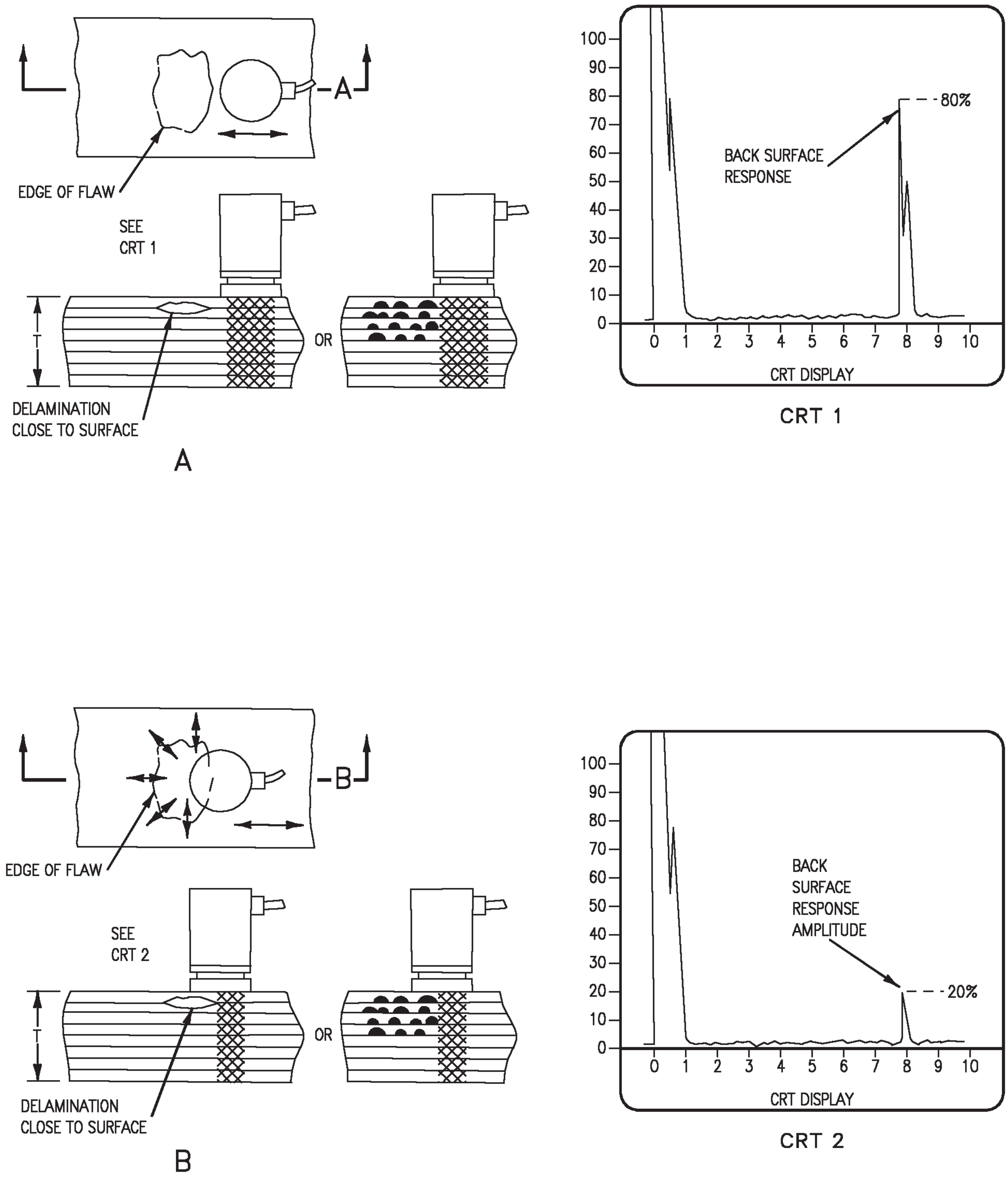


Figure 7. One Half Amplitude Mapping With Delay Line Search Unit Setup (Sheet 1)



18AC-SRM-30-(85-2)21-SCAN

Figure 7. One Half Amplitude Mapping With Delay Line Search Unit Setup (Sheet 2)



18AC-SRM-30-(86-1)21-SCAN

Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations (Sheet 1)

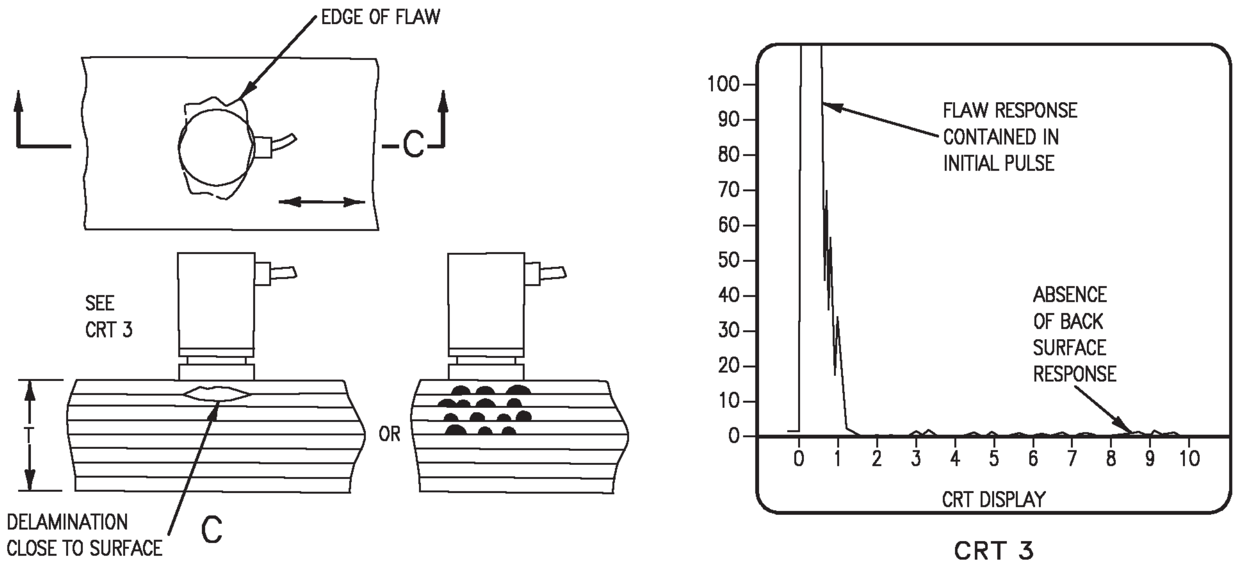


Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations (Sheet 2)

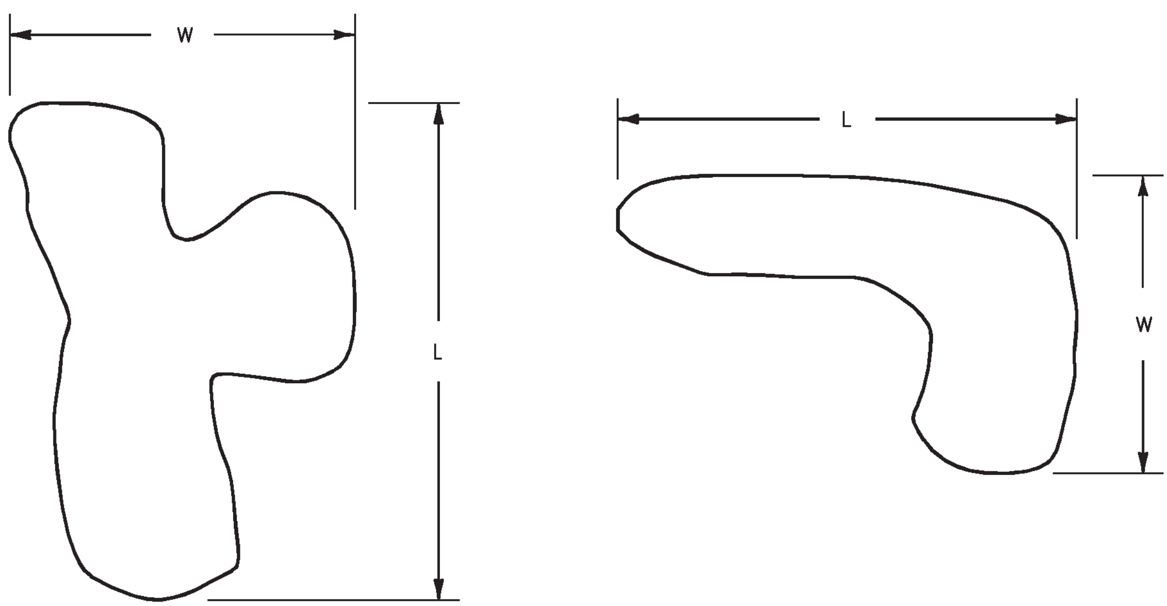


Figure 9. One Half Amplitude Mapping

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE- ECHO, LONGITUDINAL WAVE CONTACT, WITHOUT DELAY LINE, OF METALLIC MATERIALS

This WP supersedes WP008 05, dated 15 March 1993.

Reference Material

Plane Captain Manual A1-F18AC-PCM-000
Naval Aviation Maintenance Program .... OPNAVINST 4790.2

Alphabetical Index

Subject **Page No.**

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulse longitudinal, straight beam, ultrasonic waves are used to inspect metallic materials for cracks or other defects located perpendicular to metal surface. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Amplitude of reflected ultrasonic wave is also dependent on defect size.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **Personnel Qualifications.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

5. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
C-398	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia., 5 MHz, Contact Delay Line Search Unit
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 TYPE 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
—	Clear Tape, Scotch Tape

6. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot connector on connecting cable.

b. Attach BNC end of connecting cable into tester T or R BNC jack.

c. Turn tester ON, allow 15 minutes warm-up.

d. Set tester front face setting;

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COURSE SWEEP RANGE, FREQ, FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. If required, use alternate settings to produce optimum setup.

COARSE SWEEP RANGE	1.0 INCHES
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0 - 3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE-ECHO
FINE GAIN	MID SCALE
COARSE GAIN	APPROX 1
REP RATE	AUTO
FINE SWEEP RANGE	MIN
DAMPING	MID SCALE
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

e. Available reference standards for metal inspection include IIW-2 test block, see Figure 1, or flat bottom hole test blocks, see Figure 2. Either of these reference standards may be used for time-base standardization and distance amplitude curve generation for pulse-echo, longitudinal inspection of metals. Procedures for both types of reference standards are similar and are described together later in this procedure. Each type of reference standard described is available in both steel and aluminum. Reference standard used for standardization should be of same material as part(s) being inspected.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

g. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. Tester is now ready for standardization.

7. **Time-Base Standardization.**

8. **Use IIW-2 Test Block.**

a. Use Standardization of paragraph 6.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to test block at P1 position shown in figure 1.

c. Position search unit on IIW-2 test block at P1 position. See figure 1. This provides metal travel distance of 1 inch.

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

d. Adjust GAIN so peak amplitude of P1 response is at least 80 percent CRT height.

e. Adjust FINE SWEEP RANGE until P1 response leading edge is located at 2 on CRT horizontal baseline. See figure 1, CRT 2.

f. Apply couplant to P2 position on IIW-2 test block. See figure 1.

g. Position search unit on test block at P2 position. See figure 1. This provides metal travel distance of 4 inches.

h. Adjust FINE SWEEP DELAY until P2 response leading edge is located at 8 on CRT horizontal baseline. See figure 1, CRT 3.

i. Reposition search unit on P1 position.

j. Verify leading edge of P1 response is still located at 2 on CRT horizontal baseline. If not, use FINE SWEEP RANGE to relocate response leading edge at 2.

k. If adjustments were required to relocate P1 response leading edge at 2 in step j, reposition search unit at P2 position and verify P2 response leading edge is still located at 8 on CRT horizontal baseline. If not, use FINE SWEEP DELAY to relocate response leading edge at 8.

l. If adjustments were required to reposition P2 response at 8 in step k, repeat steps i through k as many times as required.

NOTE

CRT is now standardized for 5 inch range. Each of ten large divisions on CRT horizontal base line has been set to represent 0.5 inch of metal travel.

9. **Use Flat Bottom Hole Test Blocks.**

a. Use standardization of paragraph 6.

NOTE

Other flat bottom hole (FBH) test block sizes should be selected when average metal thickness of part to be inspected is less than 2.0 or larger than 5.0 Reference blocks should be chosen so average metal thickness of part to be inspected is approximately halfway between metal travel distances of blocks selected. For example, if average part thickness is 0.70, blocks with travel distances of 0.5 and 1.0 could be selected.

b. Select FBH test blocks with 1.25 and 5.0 metal travel distances.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to FBH test block with 1.25 inch travel distance.

d. Position search unit on FBH test block as shown in figure 2.

e. Adjust GAIN so peak amplitude of 1.25 response is at least 80 percent CRT height. See figure 2, CRT 1.

f. Adjust FINE SWEEP LENGTH until 1.25 response leading edge is located at 2-1/2 large divisions on CRT horizontal baseline. See figure 2, CRT 1.

g. Apply couplant to FBH test block with 5.0 travel distance.

h. Position search unit on FBH test block as shown in figure 2.

i. Adjust FINE SWEEP DELAY until 5 inch response leading edge is located at 10 on CRT horizontal baseline. See figure 2, CRT 2.

j. Reposition search unit on 1.25 FBH test block. Verify leading edge of 1.25 inch response is still located at 2-1/2 on CRT horizontal baseline. If not, use FINE SWEEP RANGE to relocate response leading edge at 2-1/2.

k. If adjustments were required to relocate 1.25 response leading edge at 2 in step j, reposition search unit on 5.0 FBH test block and verify 5.0 response leading edge is still located at 10 on CRT horizontal baseline. If not, use FINE SWEEP DELAY to relocate response leading edge at 10.

l. If adjustments were required to reposition 5.0 response at 10 in step k., repeat steps j. and k. as many times as required.

NOTE

CRT is now standardized for 5 inch range. Each of ten large divisions on CRT horizontal baseline has been set to represent 0.5 inch of metal travel.

10. **Calibration: Distance Amplitude Curve (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 13.

11. **Use IIW-2 Test Block.**

a. Determine applicable side drilled hole to use for calibration from specific procedure work package. This side drilled hole will be used to reflect ultrasonic waves entering test block from two different metal travel distances. This will enable construction of DAC to permit determination of flaw size regardless of flaw depth.

b. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to P1 position on test block.

d. Position search unit directly above selected side drilled hole as shown in figure 3.

e. Peak response from side drilled hole by moving search unit back and forth slightly.

f. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT screen height. See figure 3, CRT 1.

g. Mark amplitude of response peak on CRT with tube type marker. See figure 3, CRT 1.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

h. Apply couplant to P2 position on test block. See figure 3.

i. Position search unit at P2 position on test block as shown in figure 3.

j. Peak response from side drilled hole by moving search unit back and forth slightly.

k. Mark amplitude of hole response on tape covering CRT filter with tube type marker to establish DAC. See figure 3, CRT 1.

l. Connect points on tape covering CRT filter with tube type marker to establish DAC. See figure 3, CRT 1.

12. **Use Flat Bottom Hole Test Blocks.**

a. Select set of test blocks with 1.25, 2.50, and 5.0 metal travel distances. See figure 4.

NOTE

If other test block sizes were chosen in paragraph 7, for time-base standardization, those test blocks should also be used here. Select third test block with metal travel distance that is approximately equal to average metal thickness of part to be inspected. For example, if average part thickness is 0.70 blocks with travel distances of 0.50, 0.750, and 1.00 could be used.

b. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to surfaces of test blocks.

d. Position search unit on test block for 1.25 metal travel. See figure 4.

e. Adjust search unit for maximum response from flat bottom hole.

f. Adjust GAIN so amplitude of hole response is approximately 80 percent full CRT height. See figure 4, CRT 1.

g. Mark position of response peak on CRT using tube type marker.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

h. Position search unit on test block for 2.50 metal travel and adjust search unit to maximize response amplitude. See figure 4, CRT 1.

i. Mark position of peak tip on CRT screen with tube type marker.

j. Position search unit on test block for 5.0 of metal travel and adjust search unit to maximize response amplitude. See figure 4, CRT 1.

k. Mark position of peak tip and connect points on CRT screen with tube type marker. See figure 4, CRT 1.

13. **Inspection Procedures.**

a. Visually inspect part and record flaws or nonconformities.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

c. Before beginning inspection, determine locations of thickness, stiffeners, and other items lying beneath surface of area(s) to be inspected. This information should be described in specific procedure work packages. Lay out locations of thickness changes, stiffeners, and other sub-surface features on part surface with aircraft marking pencil and/or mylar overlay.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

d. To make sure large parts are completely inspected, mark grid pattern(s) on inspection area(s) per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 grid on inspection surface.

e. Complete setup and standardization procedures in paragraphs 6, 7, 8, and 9.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

f. Apply couplant to inspection area(s). If large area is to be inspected, apply couplant to one small area to avoid couplant evaporation.

g. Using pulse-echo, scan inspection area (s) per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 1/8-inch between scans in direction 90 degrees to scanning direction. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, or edge. Where thickness changes occur at an angle with respect to stiffeners, or edges, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid block.

h. Examples of flaw responses are described and illustrated in paragraph 14, CRT Interpretation. If flaw is suspected during scanning, proceed as follows:

NOTE

Finger damping is the process of placing couplant wetted finger on metal surface at point where it damps ultrasonic beam inside metal. If response amplitude decreases during this process, then response has been validated.

(1) Inspect for validity of response by finger damping. Remove couplant from reflecting surface before continuing.

(2) Maximize response by repositioning search unit and/or adding couplant.

NOTE

If response is equal to or above DAC, mark part using half amplitude technique described in paragraph 15 and shown in figure 6 to determine flaw boundaries. If response is not equal to or is less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or structure repair manual (SRM).

(3) If DAC is being used, remove 6 dB of additional sensitivity added for inspection, and determine whether response amplitude is equal to or above DAC.

i. Determine depth, from time-base, of all responses exceeding DAC or rejectable per specific work package and record it along with size and shape of flaw.

j. Remove couplant from serviceable part after inspection.

14. **CRT Interpretation.**

a. Crack parallel to part surface. As search unit is moved cross area containing crack parallel to part surface, second response from crack will appear in between initial pulse and back surface response. When search unit is partially covering crack, back surface response may be visible in addition to intermediate response from crack, however both responses will be reduced in amplitude compared to normal back surface response. See figure 5, CRTs 1 and 2. If search unit diameter is smaller than crack, back surface response will disappear while crack response increases in amplitude as search unit is moved over crack. When search unit completely covers crack, back surface response will no longer be visible, only intermediate response from crack is received. See figure 5, CRT 3. Depth of crack can be calculated from CRT horizontal baseline location of crack response; crack depth will be equal to CRT small horizontal baseline location of crack response multiplied by depth of material that each small horizontal baseline division has been standardized to represent. Depending on crack depth, multiples from crack response may also be visible. See figure 5, CRT 4.

b. Corrosion on inner skin surface. If corrosion on inner skin has caused very slight change in metal thickness, as search unit is moved onto area containing corroded back surface, back surface response may broaden compared to normal response, or two responses of reduced amplitude may appear. See figure 5, CRTs 5 through 7. When search unit completely covers area with slightly reduced thickness, back surface response may disappear, and response from new thickness will be increased in amplitude compared to when search unit only partially covered this area. See figure 5, CRT 8. For slight thickness changes, response location on CRT horizontal baseline may differ only slightly from normal back surface response. As reduction in metal thickness increases, response from corroded surface will move toward initial pulse on CRT. Amount of metal thickness remaining may be calculated from CRT horizontal baseline position of response: metal thickness will be equal to CRT small horizontal baseline location of response multiplied by depth of material each small horizontal baseline division has been standardized to represent.

15. **Half-Amplitude Mapping.**

a. Locate flaw. Figure 6, CRT 1, shows scanning over good area with 80 percent back reflection. Use examples in paragraph 14 on CRT Interpretation for guidelines. See figure 6, CRT 2, for example.

b. Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 6, CRT 2.

NOTE

When flaw is near surface and no response is received, set back reflection response to 80 to 90 percent CRT height. Mark surface of part when back reflection falls to 40 to 45 percent CRT height.

c. Move search unit away from center of flaw in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude, 40 percent CRT height. See figure 6, CRT 3.

d. Mark defect(s) on surface of part using aircraft marking pencil.

16. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to specific procedures in structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

c. Do paragraph 29.

17. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Delay Line Search Unit
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 TYPE 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker

Materials Required (Continued)

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
—	Clear Tape, Scotch Tape

18. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot connector on connecting cable.

b. Attach BNC end of connecting cable into tester T or R BNC jack.

c. Turn tester ON, allow 5 minutes warm-up.

d. Set tester front face setting;

NOTE

Equipment differences may require use of alternate REP-RATE, DAMP, FREQ., GAIN, and HORIZONTAL SWEEP DELAY and LENGHT.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP
HORIZONTAL SWEEP DELAY	
COURSE	5
FINE	9.0
HORIZONTAL SWEEP LENGTH	

COURSE................	10
FINE.......................	0
POLARITY....................	OFF
DISTANCE ECHO CORRECTION	OFF

e. Available reference standards for metal inspection include IIW-2 test block, see Figure 1, or flat bottom hole test blocks, see Figure 2. Either of these reference standards may be used for time-base standardization and distance amplitude curve generation for pulse-echo, longitudinal inspection of metals. Procedures for both types of reference standards are similar and are described together later in this procedure. Each type of reference standard described is available in both steel and aluminum. Reference standard used for standardization should be of same material as part(s) being inspected.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

g. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. Tester is now ready for standardization.

19. **Time-Base Standardization.**

20. **Use IIW-2 Test Block.**

a. Use Standardization of paragraph 18.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to test block at P1 position shown in figure 1.

c. 3Position search unit on IIW-2 test block at P1 position. See figure 1. This provides metal travel distance of 1 inch.

d. Adjust GAIN so peak amplitude of P1 response is at least 80 percent CRT height.

e. Adjust HORIZONTAL SWEEP LENGTH until P1 response leading edge is located at 2 on CRT horizontal baseline. See figure 1, CRT 2.

f. Apply couplant to P2 position on IIW-2 test block. See figure 1.

g. Position search unit on test block at P2 position. See figure 1. This provides metal travel distance of 4 inches.

h. Adjust HORIZONTAL SWEEP DELAY until P2 response leading edge is located at 8 on CRT horizontal baseline. See figure 1, CRT 3.

i. Reposition search unit on P1 position.

j. Verify leading edge of P1 response is still located at 2 on CRT horizontal baseline. If not, use HORIZONTAL SWEEP FINE LENGTH to relocate response leading edge at 2.

k. If adjustments were required to relocate P1 response leading edge at 2 in step j, reposition search unit at P2 position and verify P2 response leading edge is still located at 8 on CRT horizontal baseline. If not, use HORIZONTAL SWEEP FINE DELAY to relocate response leading edge at 8.

l. If adjustments were required to reposition P2 response at 8 in step k, repeat steps i through k as many times as required.

NOTE

CRT is now standardized for 5 inch range. Each of ten large divisions on CRT horizontal base line has been set to represent 0.5 inch of metal travel.

21. **Use Flat Bottom Hole Test Blocks.**

a. Use standardization of paragraph 18.

NOTE

Other flat bottom hole (FBH) test block sizes should be selected when average metal thickness of part to be inspected is less than 2.0 or larger than 5.0 Reference blocks should be chosen so average metal thickness of part to be inspected is approximately halfway between metal travel distances of blocks selected. For example, if average part thickness is 0.70, blocks with travel distances of 0.5 and 1.0 could be selected.

b. Select FBH test blocks with 1.25 and 5.0 metal travel distances.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to FBH test block with 1.25 inch travel distance.

d. Position search unit on FBH test block as shown in figure 2.

e. Adjust GAIN so peak amplitude of 1.25 response is at least 80 percent CRT height. See figure 2, CRT 1.

f. Adjust HORIZONTAL SWEEP LENGTH until 1.25 response leading edge is located at 2-1/2 large divisions on CRT horizontal baseline. See figure 2, CRT 1.

g. Apply couplant to FBH test block with 5.0 travel distance.

h. Position search unit on FBH test block as shown in figure 2.

i. Adjust HORIZONTAL SWEEP DELAY until 5 inch response leading edge is located at 10 on CRT horizontal baseline. See figure 2, CRT 2.

j. Reposition search unit on 1.25 FBH test block. Verify leading edge of 1.25 inch response is still located at 2-1/2 on CRT horizontal baseline. If not, use HORIZONTAL SWEEP FINE LENGTH to relocate response leading edge at 2-1/2.

k. If adjustments were required to relocate 1.25 response leading edge at 2 in step j, reposition search unit on 5.0 FBH test block and verify 5.0 response leading edge is still located at 10 on CRT horizontal baseline. If not, use HORIZONTAL SWEEP FINE DELAY to relocate response leading edge at 10.

l. If adjustments were required to reposition 5.0 response at 10 in step k., repeat steps j. and k. as many times as required.

NOTE

CRT is now standardized for 5 inch range. Each of ten large divisions on CRT horizontal baseline has been set to represent 0.5 inch of metal travel.

22. **Calibration: Distance Amplitude Curve (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 25.

23. **Use IIW-2 Test Block.**

a. Determine applicable side drilled hole to use for calibration from specific procedure work package. This side drilled hole will be used to reflect ultrasonic waves entering test block from two different metal travel distances. This will enable construction of DAC to permit determination of flaw size regardless of flaw depth.

b. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to P1 position on test block.

d. Position search unit directly above selected side drilled hole as shown in figure 3.

e. Peak response from side drilled hole by moving search unit back and forth slightly.

f. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT screen height. See figure 3, CRT 1.

CAUTION

Do not use grease pencil or otherwise mark directly on face of CRT filter. Damage to components will occur.

g. Mark amplitude of response peak on tape covering CRT filter with tube type marker. See figure 3, CRT 1.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

h. Apply couplant to P2 position on test block. See figure 3.

i. Position search unit at P2 position on test block as shown in figure 3.

j. Peak response from side drilled hole by moving search unit back and forth slightly.

k. Mark amplitude of hole response on tape covering CRT filter with tube type marker to establish DAC. See figure 3, CRT 1.

l. Connect points on tape covering CRT filter with tube type marker to establish DAC. See figure 3, CRT 1.

24. **Use Flat Bottom Hole Test Blocks.**

a. Select set of test blocks with 1.25, 2.50, and 5.0 metal travel distances. See figure 4.

NOTE

If other test block sizes were chosen in paragraph 19, for time-base standardization, those test blocks should also be used here. Select third test block with metal travel distance that is approximately equal to average metal thickness of part to be inspected. For example, if average part thickness is 0.70 blocks with travel distances of 0.50, 0.750, and 1.00 could be used.

b. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

c. Apply couplant to surfaces of test blocks.

d. Position search unit on test block for 1.25 metal travel. See figure 4.

e. Adjust search unit for maximum response from flat bottom hole.

f. Adjust GAIN so amplitude of hole response is approximately 80 percent full CRT height. See figure 4, CRT 1.

CAUTION

Do not use grease pencil or otherwise mark directly on the face of CRT filter. Damage to components will occur.

g. Mark position of response peak on tape covering CRT filter using tube type marker.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

h. Position search unit on test block for 2.50 metal travel and adjust search unit to maximize response amplitude. See figure 4, CRT 1.

i. Mark position of peak tip on CRT screen with tube type marker.

j. Position search unit on test block for 5.0 of metal travel and adjust search unit to maximize response amplitude. See figure 4, CRT 1.

k. Mark position of peak tip and connect points on CRT screen with tube type marker. See figure 4, CRT 1.

25. **Inspection Procedures.**

a. Visually inspect part and record flaws or nonconformities.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

c. Before beginning inspection, determine locations of thickness, stiffeners, and other items lying beneath surface of area(s) to be inspected. This information should be described in specific procedure work packages. Lay out locations of thickness changes, stiffeners, and other sub-surface features on part surface with aircraft marking pencil and/or mylar overlay.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

d. To make sure large parts are completely inspected, mark grid pattern(s) on inspection area(s) per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 grid on inspection surface.

e. Complete setup and standardization procedures in paragraphs 18., 19., 20., and 21.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

f. Apply couplant to inspection area(s). If large area is to be inspected, apply couplant to one small area to avoid couplant evaporation.

g. Using pulse-echo, scan inspection area (s) per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 1/8-inch between scans in direction 90 degrees to scanning direction. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, or edge. Where thickness changes occur at an angle with respect to stiffeners, or edges, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid block.

h. Examples of flaw responses are described and illustrated in paragraph 26, CRT Interpretation. If flaw is suspected during scanning, proceed as follows:

NOTE

Finger damping is the process of placing couplant wetted finger on metal surface at point where it damps ultrasonic beam inside metal. If response amplitude decreases during this process, then response has been validated.

(1) Inspect for validity of response by finger damping. Remove couplant from reflecting surface before continuing.

(2) Maximize response by repositioning search unit and/or adding couplant.

NOTE

If response is equal to or above DAC, mark part using half amplitude technique described in paragraph 27 and shown in figure 6 to determine flaw boundaries. If response is not equal to or is less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or structure repair manual (SRM).

(3) If DAC is being used, remove 6 dB of additional sensitivity added for inspection, and determine whether response amplitude is equal to or above DAC.

i. Determine depth, from time-base, of all responses exceeding DAC or rejectable per specific work package and record it along with size and shape of flaw.

j. Remove couplant from serviceable part after inspection.

26. **CRT Interpretation.**

a. Crack parallel to part surface. As search unit is moved cross area containing crack parallel to part surface, second response from crack will appear in between initial pulse and back surface response. When search unit is partially covering crack, back surface response may be visible in addition to intermediate response from crack, however both responses will be reduced in amplitude compared to normal back surface response. See figure 5, CRTs 1 and 2. If search unit diameter is smaller than crack, back surface response will disappear while crack response increases in amplitude as search unit is moved over crack. When search unit completely covers crack, back surface response will no longer be visible, only intermediate response from crack is received. See figure 5, CRT 3. Depth of crack can be calculated from CRT horizontal baseline location of crack response; crack depth will be equal to CRT small horizontal baseline location of crack response multiplied by depth of material that each small horizontal baseline division has been standardized to represent. Depending on crack depth, multiples from crack response may also be visible. See figure 5, CRT 4.

b. Corrosion on inner skin surface. If corrosion on inner skin has caused very slight change in metal thickness, as search unit is moved onto area containing corroded back surface, back surface response may broaden compared to normal response, or two responses of reduced amplitude may appear. See figure 5, CRTs 5 through 7. When search unit completely covers area with slightly reduced thickness, back surface response may disappear, and response from new thickness will be increased in amplitude compared to when search unit only partially covered this area. See figure 5, CRT 8. For slight thickness changes, response location on CRT horizontal baseline may differ only slightly from normal back surface response. As reduction in metal thickness increases, response from corroded surface will move toward initial pulse on CRT. Amount of metal thickness remaining may be calculated from CRT horizontal baseline position of response: metal thickness will be equal to CRT small horizontal baseline location of response multiplied by depth of material each small horizontal baseline division has been standardized to represent.

27. **Half-Amplitude Mapping.**

a. Locate flaw. Figure 6, CRT 1, shows scanning over good area with 80 percent back reflection. Use examples in paragraph 13 on CRT Interpretation for guidelines. See figure 6, CRT 2, for example.

b. Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 6, CRT 2.

NOTE

When flaw is near surface and no response is received, set back reflection response to 80 to 90 percent CRT height. Mark surface of part when back reflection falls to 40 to 45 percent CRT height.

c. Move search unit away from center of flaw in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude, 40 percent CRT height. See figure 6, CRT 3.

d. Mark defect(s) on surface of part using aircraft marking pencil.

28. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to specific procedures in structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

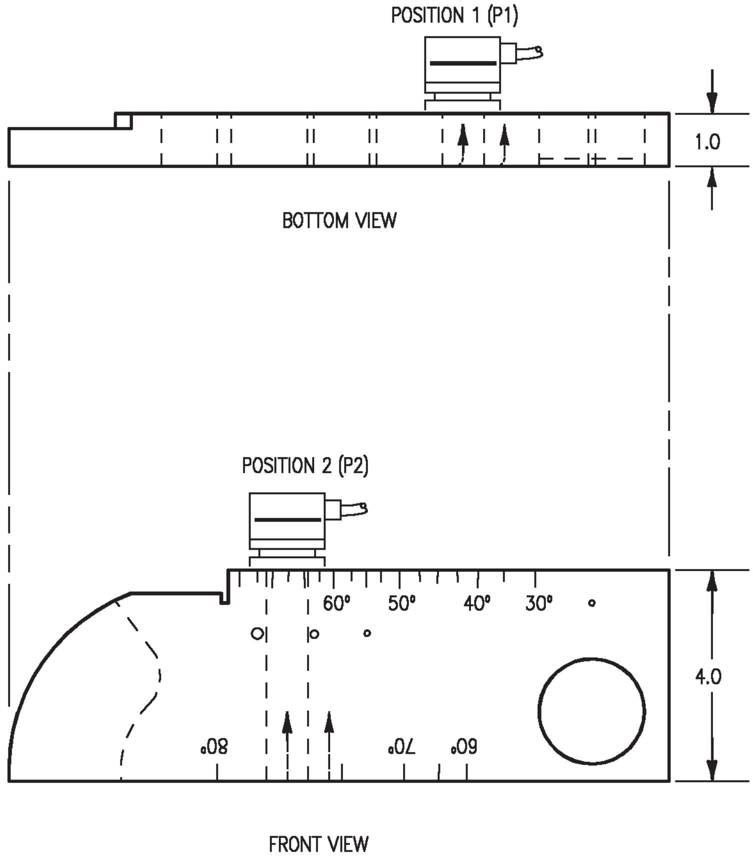
WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

29. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cloth moistened with cleaning compound to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.



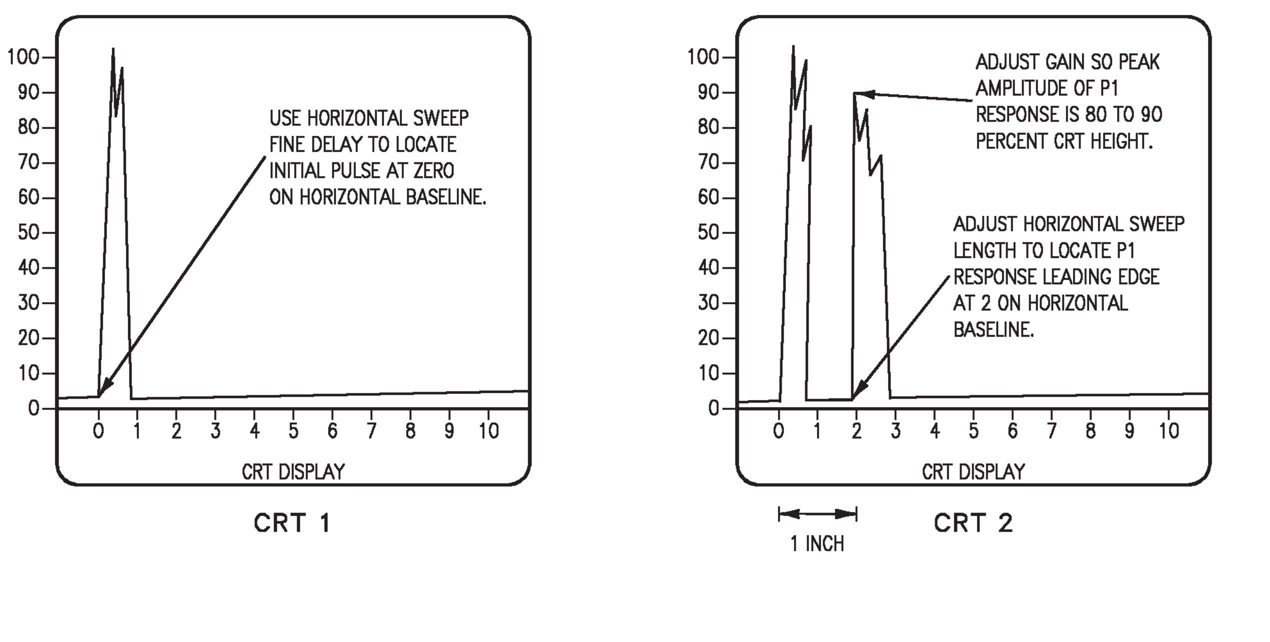
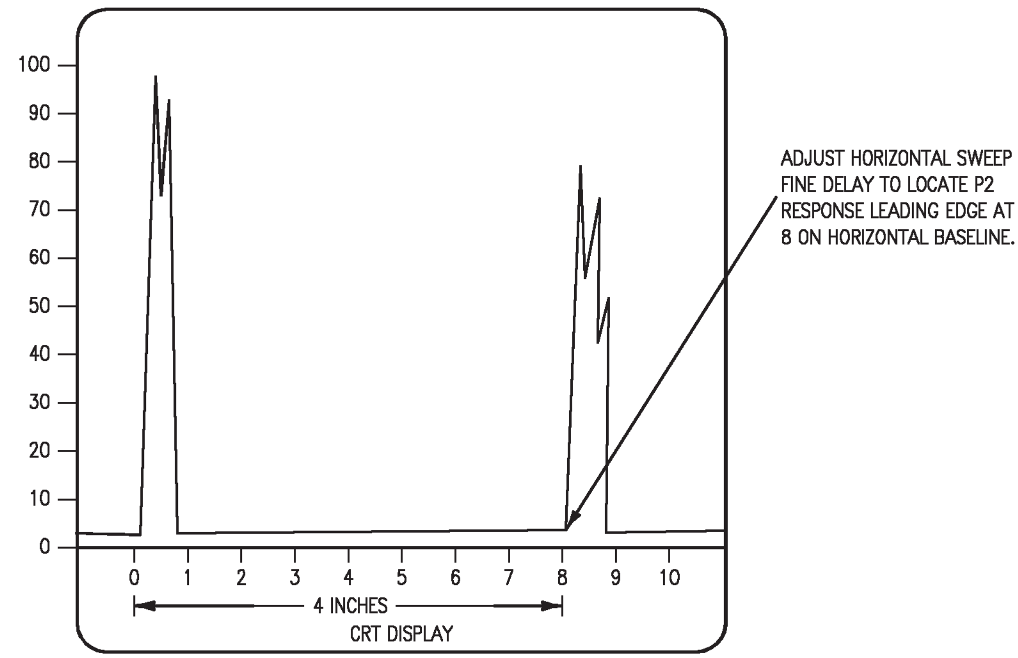


Figure 1. Time Base Standardization for Straight Beam Search Unit with IIW-2 Test Block (Sheet 1)



CRT 3

18AC-SRM-30-(389-2)31-CATI

Figure 1. Time Base Standardization for Straight Beam Search Unit with IIW-2 Test Block (Sheet 2)

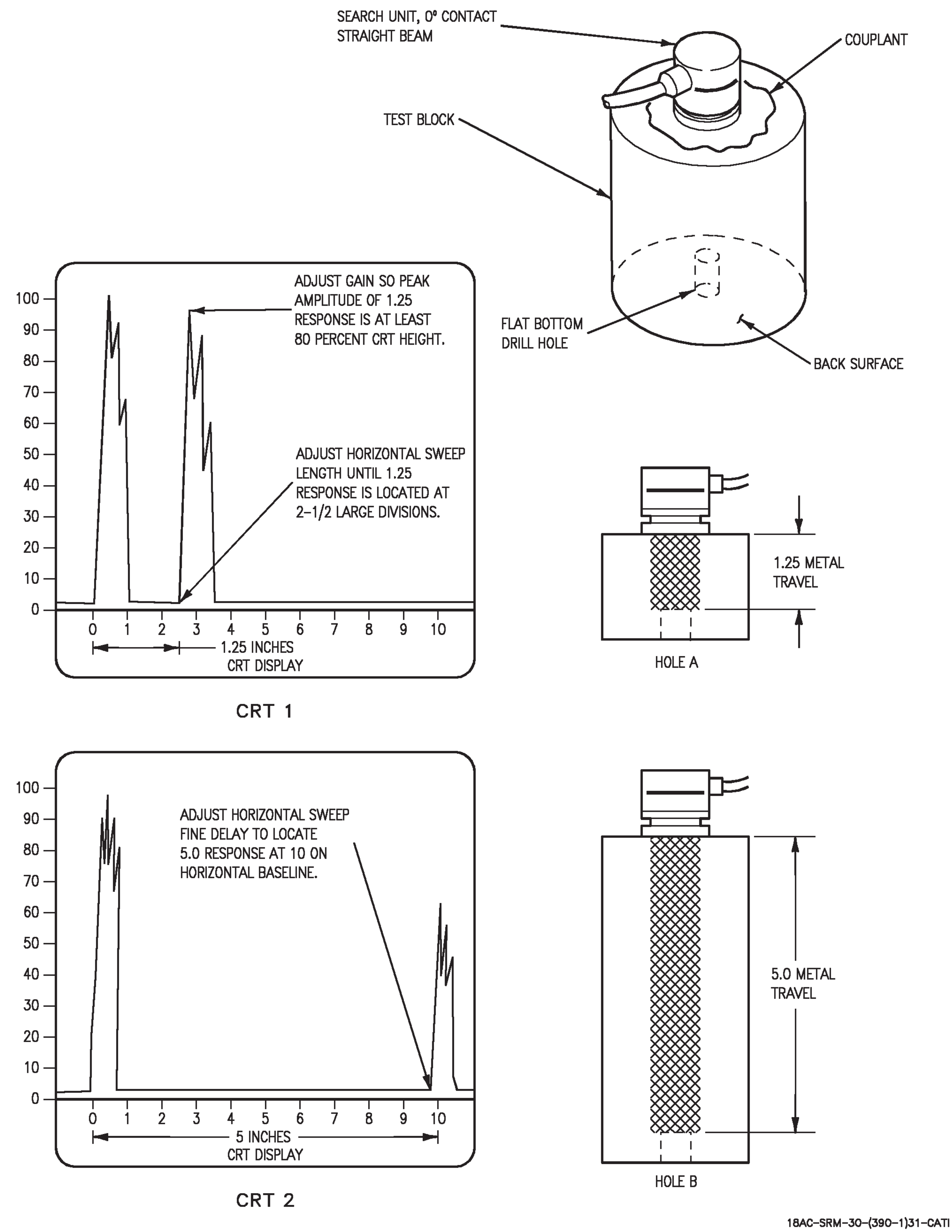
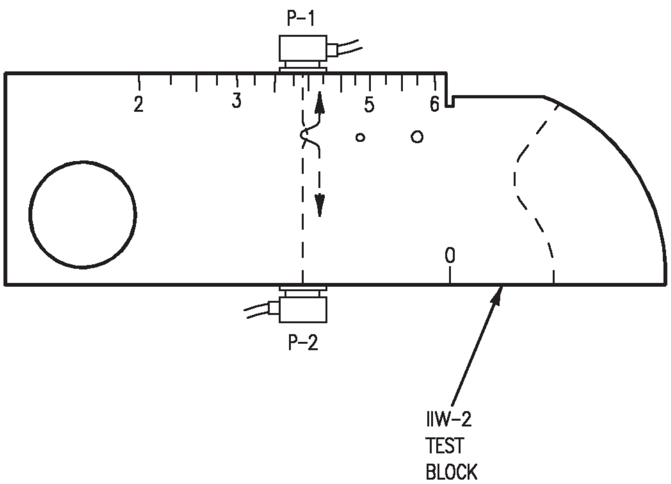
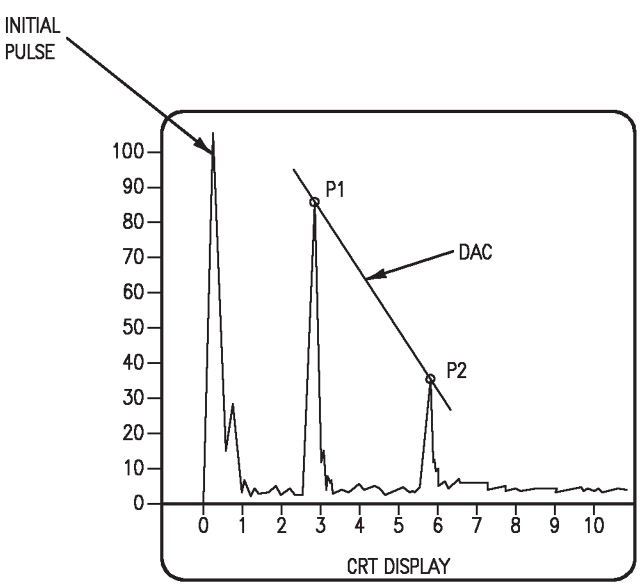


Figure 2. Time Base Standardization for Straight Beam Search Unit Using Flat Bottom Hole Test Block





CRT 1

LEGEND

1. APPLY COUPLANT UNDER SEARCH UNIT
2. DETERMINE APPLICABLE HOLE AND SEARCH UNIT FROM OTHER SECTION
3. OBTAIN PEAK SIGNAL FROM SIDE OF HOLE AT P-1
4. SET SENSITIVITY LEVEL TO 90% AMPLITUDE AND MARK POSITION ON CRT
5. OBTAIN PEAK SIGNAL FROM SIDE OF HOLE AT P-2 AND MARK POSITION AND HEIGHT ON CRT
6. CONNECT POINTS FOR DAC AS ILLUSTRATED

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Figure 3. Construction of DAC Using IIW-2 Test Block

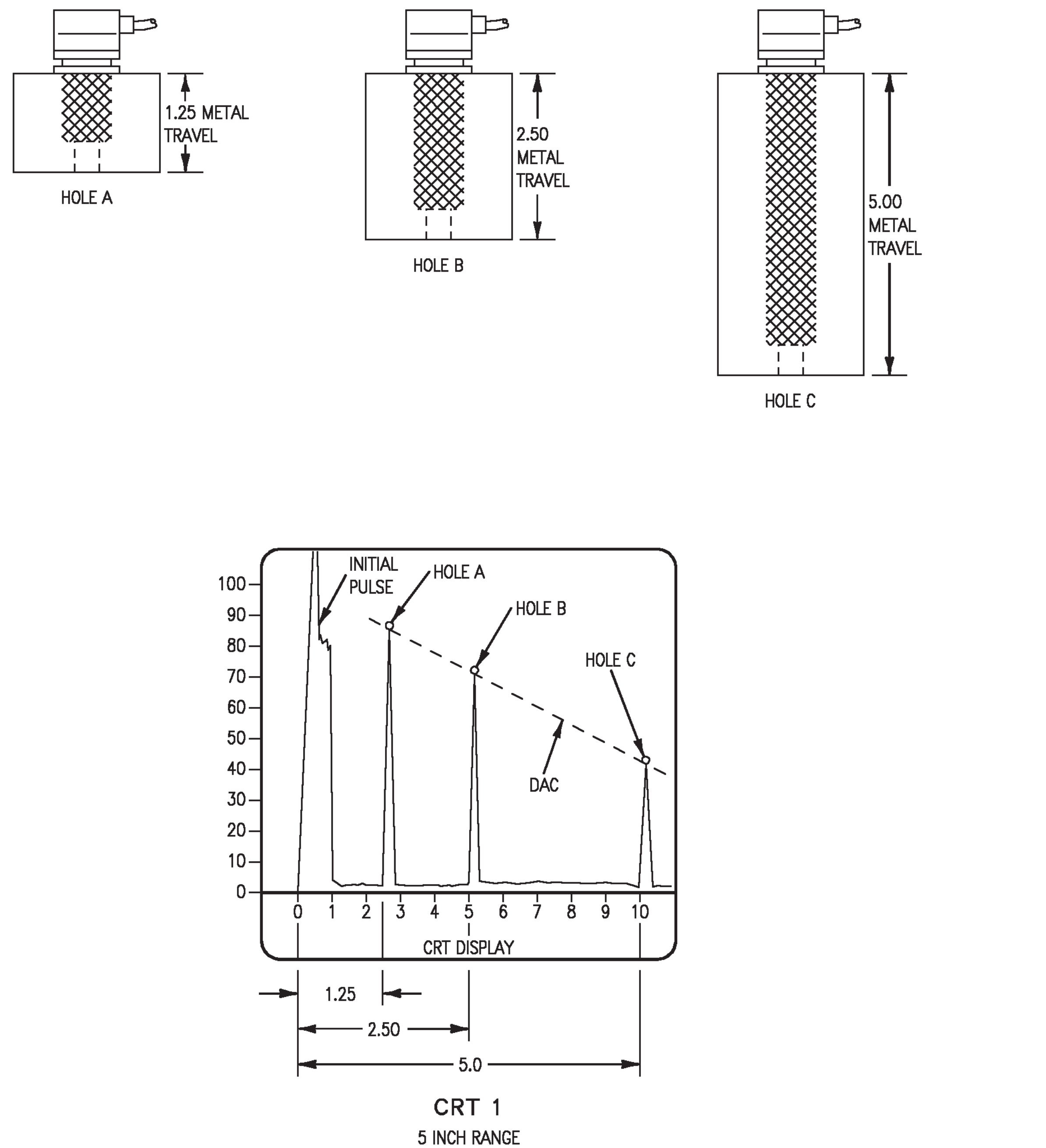
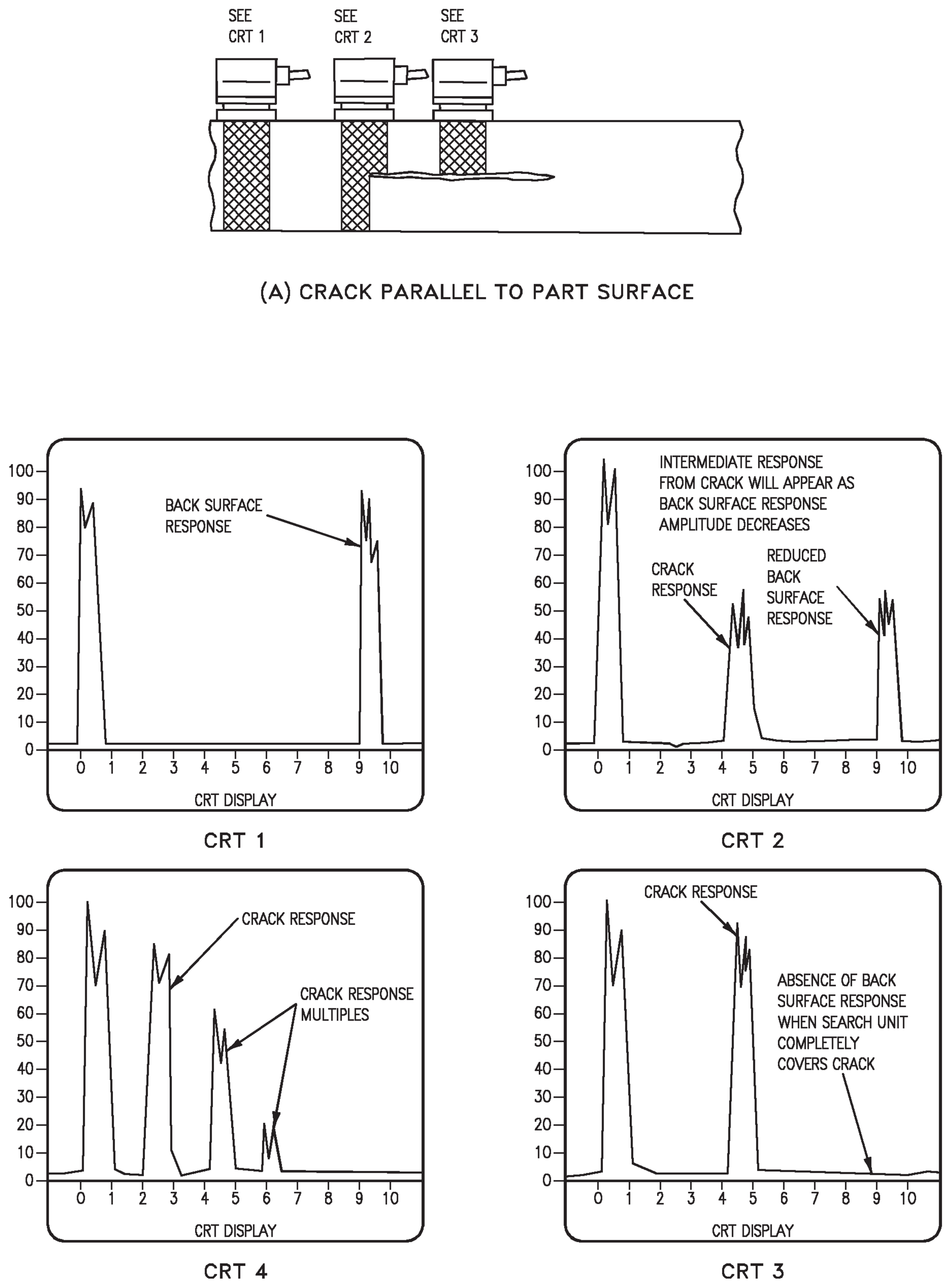


Figure 4. Construction of DAC Using FBH Test Blocks



18AC-SRM-30-(393-1)31-SCAN

Figure 5. Typical Flaw Responses (Sheet 1)

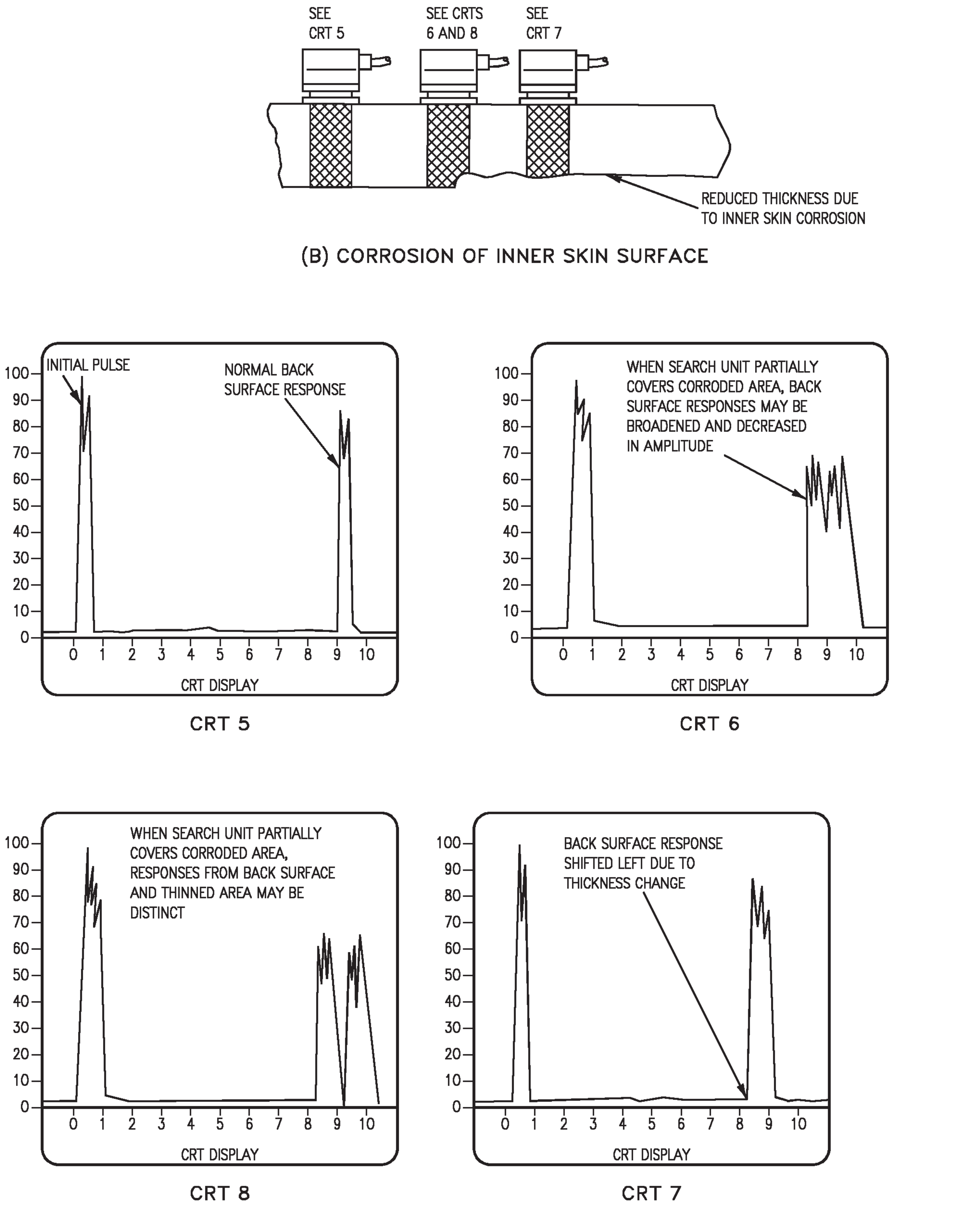
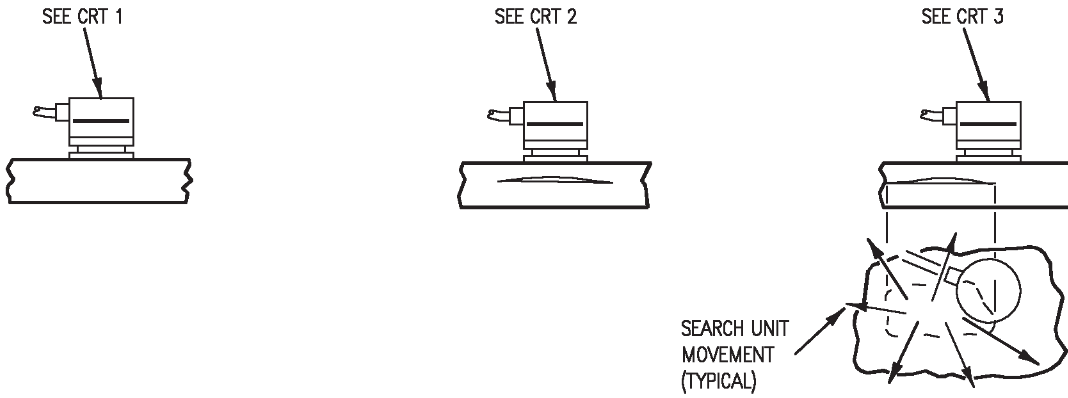
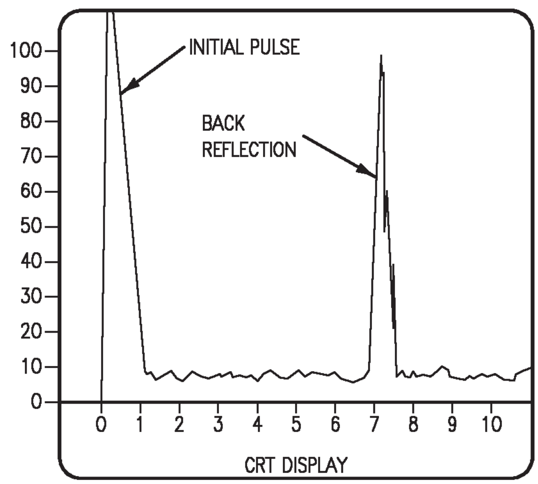
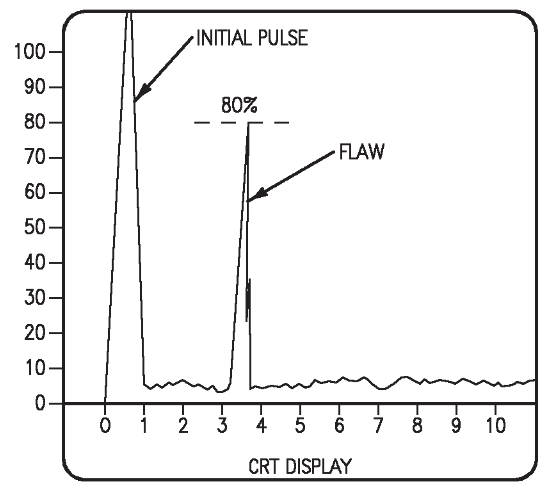


Figure 5. Typical Flaw Responses (Sheet 2)

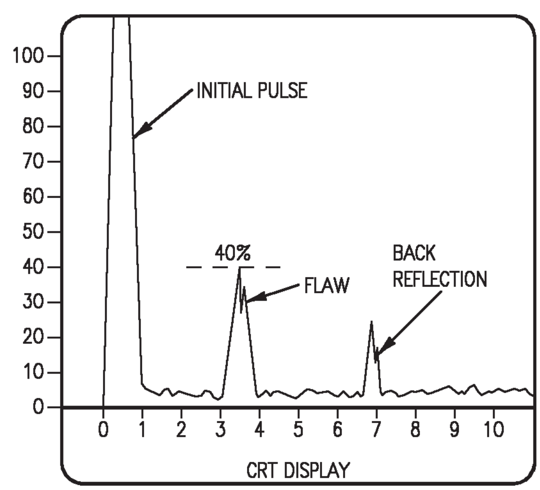




CRT 1



CRT 2



CRT 3

LEGEND

HALF AMPLITUDE MAPPING TECHNIQUE

1. LOCATE FLAW, SEE CRT 2.
2. ADJUST GAIN UNTIL THE MAXIMIZED FLAW RESPONSE REACHES 80 TO 90 PERCENT OF CRT HEIGHT, SEE CRT 2.
3. MOVE SEARCH UNIT AWAY FROM CENTER OF FLAW IN ALL DIRECTIONS. MARK SURFACE OF PART UNDER CENTER OF SEARCH UNIT WHEN AMPLITUDE OF RESPONSE REACHES 40 PERCENT OF CRT HEIGHT, SEE CRT 3.
4. WHEN FLAW IS SUPERFICIAL AND NO RESPONSE IS RECEIVED, USE THE SAME METHOD BUT SET BACK REFLECTION TO 80 TO 90 PERCENT AND MARK SURFACE OF PART UNDER CENTER OF SEARCH UNIT WHEN BACK REFLECTION FALLS TO 40 TO 45 PERCENT.

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Figure 6. Half Amplitude Measurement with Straight Beam Ultrasonic Method

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC RESONANCE INSPECTION WITH FOKKER BOND TESTER

This WP supersedes WP008 06, dated 1 December 1992.

Reference Material

Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. GENERAL INFORMATION.

2. Fokker bond tester (bond tester) is ultrasonic resonance - impedance instrument, with piezo electric transducer used as sensor. Bond tester imposes defined band of frequencies on piezo electric crystal, causing crystal to vibrate at one of its own natural resonance frequencies.

a. When vibrating crystal is coupled to structure to be inspected this natural resonance frequency will be influenced by mass coupled to it. Figure 1 shows resonance test setup and vibrating system represented by transducer and bonded part under inspection. Two bar graphs and two numeric displays are used to monitor resonance frequency, called A-scale, and voltage drop across transducer, called B-scale. Figure 2 shows front of bond tester and figure 3 shows typical good bond and unbond responses.

b. Piezo electric crystal is barium titanate. Fact barium titanate is piezo electric means pressure in certain direction will create electrical voltage across both electrodes on crystal. Also, crystal will be deformed under influence of voltage over electrodes.

c. Barium titanate transducer used with bond tester is cylindrically shaped with upper and lower surfaces plated with either nickel or chromium. When plating shows signs of wear, transducer should be replaced.

d. Transducer is suspended in probe adapter assembly shown in figure 4. Suspension allows transducer to vibrate freely in all directions.

e. Typical resonance spectrum of Fokker transducer is shown in figure 5. At X and Y sudden change in voltage occurs over transducer because transducer itself joins vibration in frequency supplied to it. Vibration is called natural resonance

frequency of transducer and is determined by its dimensions.

f. Various transducers employed in bond tester are coded as to diameter and thickness. First and second figure give diameter and third and fourth figure give thickness. For example, transducer 3412 has a diameter of 3/4-inch and thickness of 1/2-inch.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding when using bond tester near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **SUPPORT EQUIPMENT AND MATERIALS.** Equipment and materials used are typical for all bond tester procedures in this work package.

Support Equipment Required

Part Number or Type Designation	Nomenclature
Model 80	Fokker Bond Tester
3814	Fokker Probe
3412	Fokker Probe
Yellow Bond Tester Adapter	Probe Adapter Assembly

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-I-25135	Penetrant Emulsifier
ULTRAGEL II	Ultrasonic Couplant
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
M83953-1 or -2	Pencil, Aircraft Marking

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP FOR FOKKER BOND TESTER.** See figure 2.

a. Turn bond tester on by depressing ON button for 1 second.

b. Press DSP to activate numeric display.

c. Set MODE, SWEEP RATE (S), SWEEP RANGE (R), and FREQUENCY (F) to settings specified in specific procedure work package.

d. Select probe and probe adapter specified in specific procedure work package.

e. Assemble probe and adapter units.

f. Connect probe adapter assembly and cable to probe connection on bond tester, see figure 2.

g. Adjust FREQ. FINE to get 0 ±1 KHz on A-scale numeric display. This will center A-scale bar graph at 0 ±1 KHz.

h. Adjust GAIN to get 100 ±5°ba on B-scale numeric display. B-scale bar graph will also display 100 ±5°.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

i. Apply couplant to test surface of reference standard required in specific procedure work package.

j. Position probe on reference standard required by specific procedure work package.

k. Adjust FREQ. FINE to get A-scale display of 0 ±1 KHz.

l. Adjust GAIN to get B-scale display of 100 ±5°.

NOTE

Magnitude and direction of A-scale and B-scale shifts will be dependent on inspection area configuration. See specific work package for typical response.

m. Position probe on reference standard representing good bond or known good bond area and verify shift in A-scale and/or B-scale display.

6. **INSPECTION PROCEDURES.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to inspection area(s) shown in specific procedure work package.

b. Position probe on inspection area(s) of specific procedure work package and scan using scan index given or one not exceeding 1/2 probe diameter.

c. Inspect bond line by monitoring A and B scale presentations.

d. Mark and record, using aircraft marking pencil, all areas displaying unbond response, see specific procedure work package for unbond response.

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/ prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

7. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection material and marks from inspection area(s) with solvent moistened cloth.

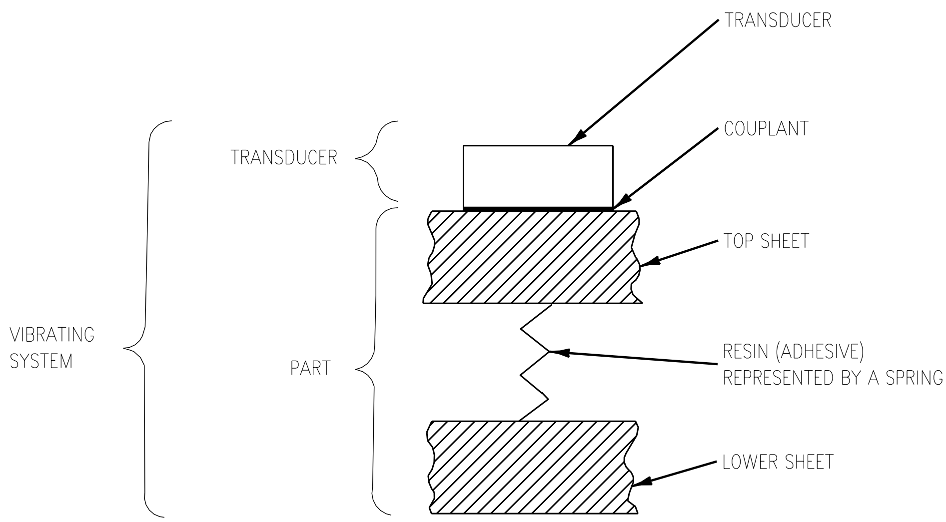
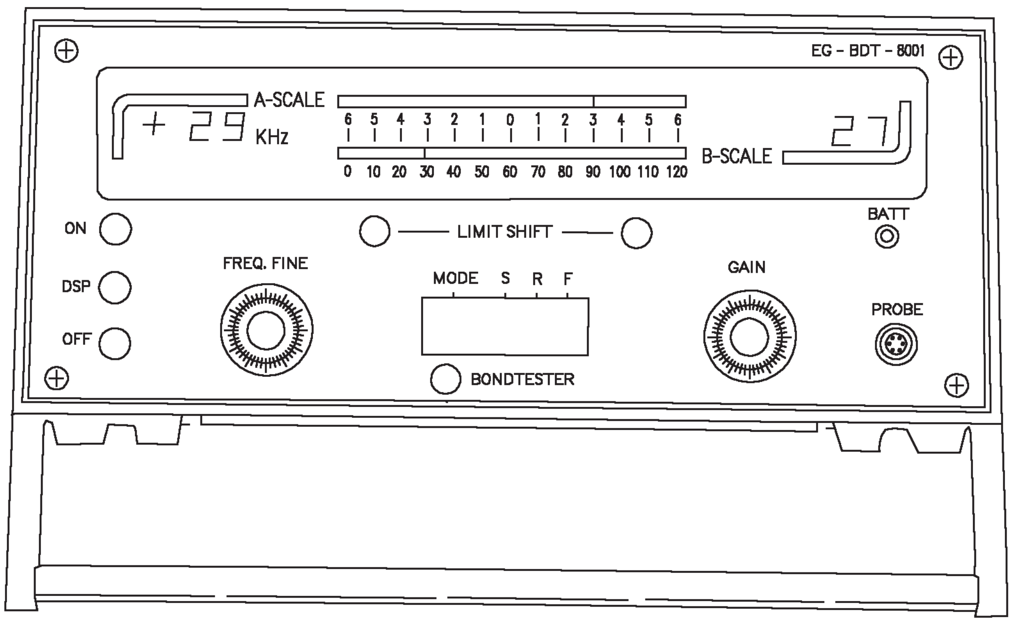
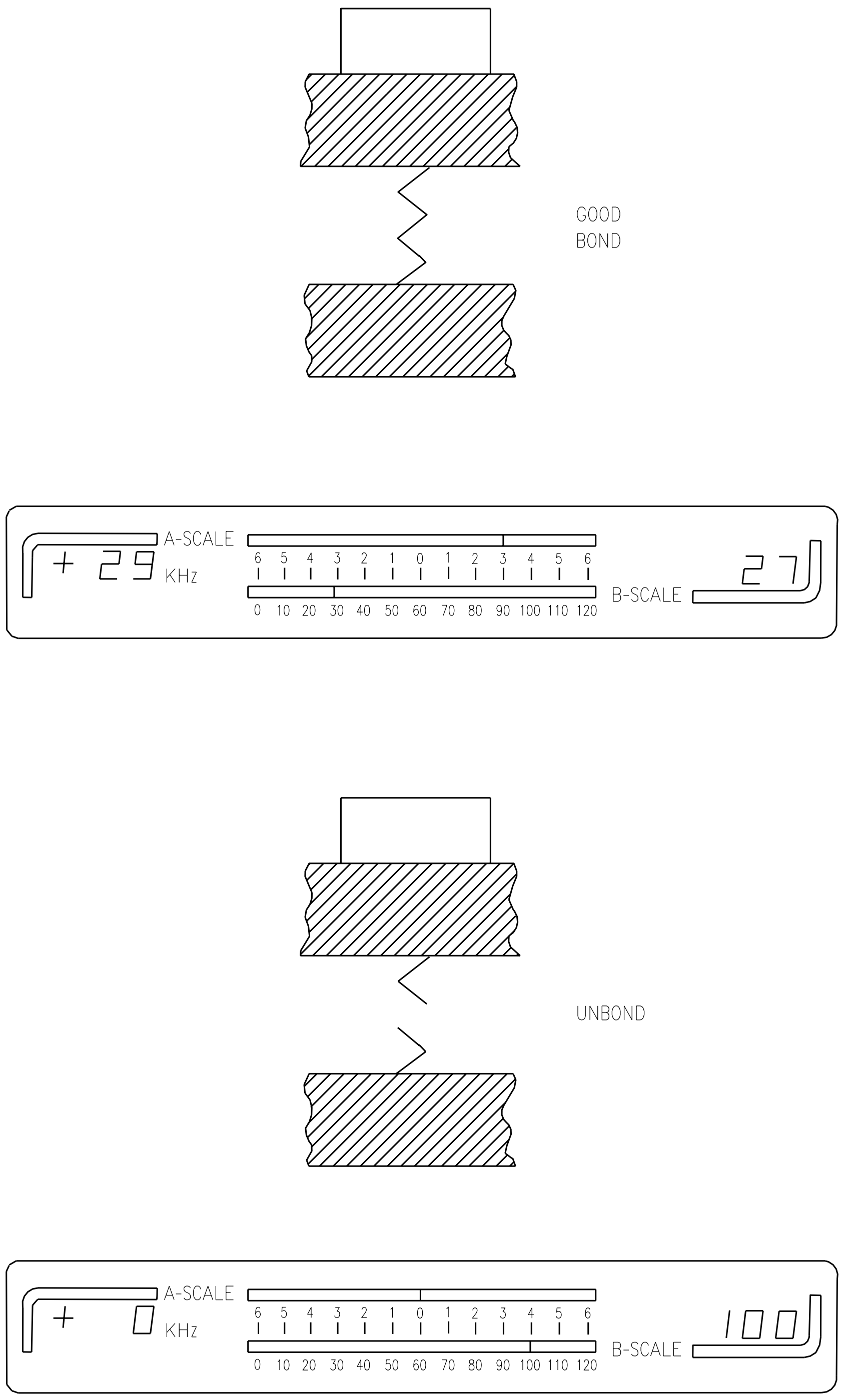


Figure 1. Schematic of Ultrasonic Resonance Test Setup and Vibrating System



18AC-SRM-30-(89-1)22-SCAN

Figure 2. Controls for Model 80 Fokker Bond Tester



18AC-SRM-30-(88-1)21-SCAN

Figure 3. Typical Good Bond/Unbond Responses

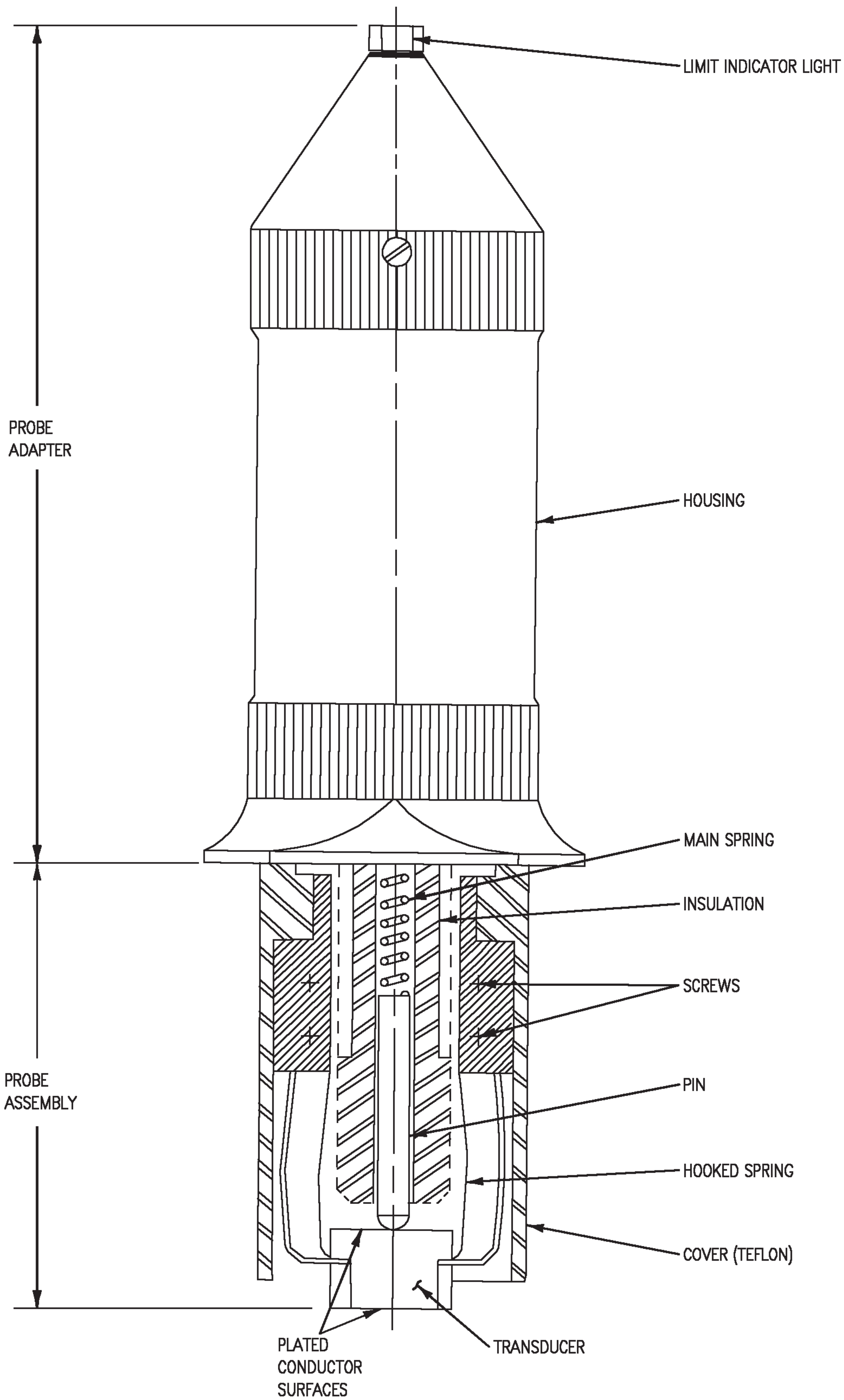


Figure 4. Probe Adapter Assembly for Model 80 Fokker Bond Tester

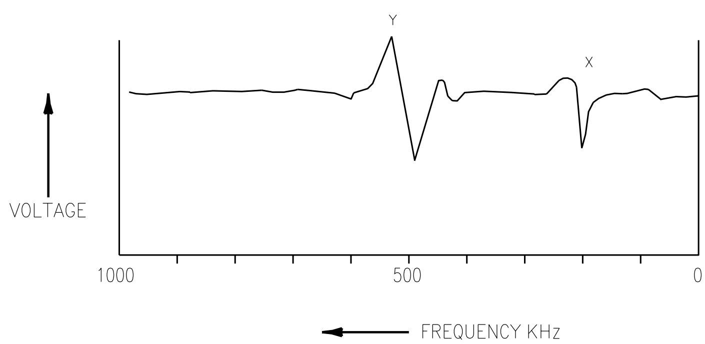


Figure 5. Typical Resonance Spectrum of Fokker Transducer

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO SURFACE WAVE CONTACT, OF METALLIC MATERIALS

Reference Material

Plane Captain Manual A1-F18AC-PCM-000
Naval Aviation Maintenance Program .... OPNAVINST 4790.2

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. Surface waves, Rayleigh waves, are used to inspect metallic materials for surface flaws, such as cracks, or discontinuities located just below surface. Angle beam transducer containing steeply angled wedge is used. Steep angle causes longitudinal beam to strike test surface at angle which results in surface mode of sound propagation. Surface waves will travel around curves or contours. Surface waves are reflected from sharp corners. Surface waves rapidly decay below part surface. Subsurface defects located up to about one-half wavelength below surface can be detected with surface waves.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **Personnel Qualifications.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

5. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
C-398	Ultrasonic Flaw Detector Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
57A2214 or EQUIVALENT	90°, 0.250 Dia, 5 MHz, Contact Search Unit
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 TYPE 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
—	Clear Tape, Scotch Tape

6. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot connector on connecting cable.

b. Attach BNC end of connecting cable into ultrasonic flaw detector (tester) T or R BNC jack.

c. Turn tester ON, allow 15 minutes warm-up.

d. Set tester front face setting;

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COURSE SWEEP RANGE, FREQ. FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. If required, use alternate settings to produce optimum setup.

COARSE SWEEP RANGE	10 INCHES
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0 - 3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE-ECHO
FINE GAIN	MID SCALE
COARSE GAIN	APPROX 2
REP RATE	AUTO
FINE SWEEP RANGE	MIN
DAMPING	MID SCALE
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

e. Choose either aluminum or steel test block for standardization and calibration, depending on material to be inspected.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

g. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. Flaw detector is now ready for standardization.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

7. **Time-Base Standardization.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to IIW-2 test block at 0 mark as shown in figure 1.

b. Position specified search unit on IIW-2 test block at 0 mark. See figure 1.

NOTE

Location of initial pulse may shift on CRT horizontal baseline when FINE SWEEP DELAY AND RANGE adjustments are made to locate responses from interfaces A and B at 4 and 8 on CRT horizontal baseline.

c. Adjust FINE SWEEP RANGE and DELAY until two responses are visible on CRT. See figure 1, CRT 2.

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

d. Adjust GAIN so peak amplitude of first response is at least 80 percent CRT height. See figure 1, CRT 2.

e. Adjust FINE SWEEP DELAY to locate response from interface A, first response, at 4 on CRT horizontal baseline. Adjust FINE SWEEP RANGE to locate response from interface B, second response, at 8 on CRT horizontal baseline, Repeat this process as many times as required. See figure 1, CRT 3.

NOTE

Minimum REJECT is recommended.

f. Use DAMP, and REJECT to optimize response and minimize baseline noise.

g. Tester is now standardized so each of ten large divisions on CRT horizontal baseline represents 0.50 inches. Horizontal distance from 0 to 10 represents metal travel distance of 5 inches. See figure 1, CRT 3.

8. **Calibration: Distance Amplitude Curve, (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 9.

a. Determine applicable side drilled hole to use for calibration from specific procedure work package.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to position P1 or P2 on IIW-2 test block as shown in figure 2, depending on which side drilled hole is specified in specific procedure work package.

c. Position search unit approximately 1 inch from applicable side drilled hole and peak response from side drilled hole by moving search unit back and forth slightly. See P1 in figure 2.

d. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT height. See figure 2, CRT 1.

e. Mark response on transparent tape covering CRT screen filter using tube type marker.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

f. Remove all couplant in between side drilled hole and location on reference block that is 3 inches from selected side drilled hole.

g. Position search unit approximately 3 inches from selected side drilled hole and peak response of search unit by moving search unit back and forth slightly.

h. Mark response on transparent tape covering CRT screen filter using tube type marker. See figure 2, CRT 1.

i. Connect points on CRT with tube type marker to establish distance amplitude curve (DAC). See figure 2, CRT 1.

9. **Surface Wave Inspection Procedure.**

a. Visually inspect part and record flaws or nonconformities.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to area of part to be inspected.

NOTE

Where grid is required, apply couplant to only one grid block and complete inspection in that area before applying couplant to next grid block.

c. Note dB level selected during DAC establishment and add additional 6 dB sensitivity for scanning. If DAC is not specified in specific work package, add 6 dB to gain established in specific procedure work package.

NOTE

When approaching thickness change, scan toward thicker section if possible. Responses will result from abrupt thickness changes. Scan parallel to radii with sound beam perpendicular to radius to best detect radius cracks.

d. Scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 3 inches in direction of beam centerline between scans. Unless other instructions are specified in specific procedure work package, scan by passing search unit in linear direction while swiveling search unit from right to left with in included angle of 40°. Scan at rate no greater than that established when detecting holes in IIW-2 test block. If grid is required, scan entire area within one grid block before inspecting next grid block.

e. Remove excess couplant in front of search unit, since excess couplant can either damp surface waves or produce responses.

f. Examples of flaw responses are described and illustrated in paragraph 10, CRT Interpretation. If flaw is suspected during scanning, proceed as follows:

(1) Determine response source by finger damping. Place couplant wetted finger, cotton swab, or pencil eraser in front of search unit and move finger, swab, or eraser toward suspected source. Response should decrease in amplitude until finger, swab, or eraser is moved past source.

(2) Peak response from suspected defect by repositioning search unit and/or adding couplant.

(3) Remove 6 dB of additional sensitivity and determine if response amplitude remains equal to or above DAC if DAC curve is being used. When specific work procedure requires DAC, and response is equal to or above DAC, mark part using half amplitude technique described in paragraph 10 and shown in figure 4 to determine flaw boundaries. If response is not equal to or is less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or in specific procedures in structure repair manuals

(A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

10. **CRT Interpretation.**

NOTE

Always verify source of response. Position couplant wetted finger, cotton swab, or pencil eraser between search unit and suspected response and gradually move finger or cotton swab toward suspected source to damp response. Response should decrease in amplitude until finger, cotton swab, or eraser is moved beyond suspected source. See figure 3, CRT 1.

a. Edge of skin. Figure 3, CRT 2 shows example of response from edge of skin section. As search unit is moved toward edge, response will shift toward initial pulse on CRT horizontal baseline and increase in amplitude.

NOTE

To continually verify coupling is good, look for responses from natural reflectors such as edges or holes.

b. Holes with or without countersinks. Holes with or without countersinks will produce one response. If hole is near edge, edge response may or may not also be visible on CRT. As search unit is moved toward hole, response will shift toward initial pulse on CRT horizontal baseline and increase in amplitude. See figure 3, CRTs 4 and 5.

NOTE

Surface protective coatings will also dampen surface waves.

c. Crack responses. Ridges, scratches, cracks, and cracked or chipped paint can often produce responses. Examples are shown in figure 3, CRTs 6 through 10. Back surface response may be visible in addition to crack response. See figure 3, CRT 6. Multiple responses may result from cracks at or near fastener holes, figure 3, CRTs 7 and 8. CRT 9 shows response from crack thickness change. Cracks may also occur at radii in stiffeners, flanges, and steps. Always scan parallel to radii with sound beam perpendicular to radius to best detect radius cracks. See figure 3, CRTs 10 and 11. Crack responses will increase in amplitude and move toward initial pulse as search unit is moved toward crack.

d. Thickness changes. If possible, scan toward thicker sections at thickness changes, since responses can result from thickness changes when approaching thinner sections. See figure 3, CRTs 12 and 13.

e. Responses from radii. Even if there are no cracks or flaws in radius section, responses may result from radius. More than one response may result from different surfaces of radius. For example, responses may result from both surfaces of stiffener. See figure 3, CRTs 14 and 15.

f. Excess couplant. Responses may result from beads of excess couplant on surface, figure 3, CRT 16. Excess couplant can also damp surface waves, resulting in inferior test. Make sure there is no excess couplant in front of search unit.

11. **Half-Amplitude Mapping.**

a. Adjust GAIN so maximum amplitude received from flaw is approximately 95 percent full CRT height. See figure 4, CRT 1.

b. Move search unit parallel to defect while maintaining same sound travel distance. When flaw response amplitude drops to 45 to 50 percent full CRT height, mark part along centerline of search unit. See figure 4, CRT 2. Use this technique to mark both ends of flaw.

12. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to specific procedures in structure repair manuals A1-F18AC-SRM-210 through (A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Define damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

c. Do paragraph 21.

13. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	90°, 0.250 Dia 5 MHz, Contact Search Unit
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 TYPE 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker
ULTRAGEL II OR EQUIVALENT	Couplant
M83953-1 or -2	Pencil, Aircraft Marking
—	Clear Tape, Scotch Tape

14. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot connector on connecting cable.

b. Attach BNC end of connecting cable into ultrasonic flaw detector (tester) T or R BNC jack.

c. Turn tester ON, allow 5 minutes warm-up.

d. Set tester front face setting;

NOTE

Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	80 (dB)
COURSE GAIN	8
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	50
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	10
FINE	7.0
POLARITY	OFF
DISTANCE ECHO CORRECTION	OFF

e. Choose either aluminum or steel test block for standardization and calibration, depending on material to be inspected.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection

area(s) is free of contamination or foreign material.

g. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. Flaw detector is now ready for standardization.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

15. **Time-Base Standardization.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to IIW-2 test block at 0 mark as shown in figure 1.

b. Position specified search unit on IIW-2 test block at 0 mark. See figure 1.

NOTE

Location of initial pulse may shift on CRT horizontal baseline when HORIZONTAL SWEEP DELAY AND LENGTH adjustments are made to locate responses from interfaces A and B at 4 and 8 on CRT horizontal baseline.

c. Adjust HORIZONTAL SWEEP LENGTH and DELAY until two responses are visible on CRT. See figure 1, CRT 2.

d. Adjust GAIN so peak amplitude of first response is at least 80 percent CRT height. See figure 1, CRT 2.

e. Adjust HORIZONTAL SWEEP FINE DELAY to locate response from interface A, first response, at 4 on CRT horizontal baseline. Adjust HORIZONTAL SWEEP FINE LENGTH to locate response from interface B, second response, at 8 on CRT horizontal baseline, Repeat this process as many times as required. See figure 1, CRT 3.

NOTE

Minimum REJECT is recommended.

f. Use DAMP, and REJECT to optimize response and minimize baseline noise.

g. Tester is now standardized so each of ten large divisions on CRT horizontal baseline represents 0.50 inches. Horizontal distance from 0 to 10 represents metal travel distance of 5 inches. See figure 1, CRT 3.

16. **Calibration: Distance Amplitude Curve, (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 17.

CAUTION

Do not use grease pencil directly on face of CRT filter. Damage to components will occur.

a. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

b. Determine applicable side drilled hole to use for calibration from specific procedure work package.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to position P1 or P2 on IIW-2 test block as shown in figure 2, depending on which side drilled hole is specified in specific procedure work package.

d. Position search unit approximately 1 inch from applicable side drilled hole and peak response from side drilled hole by moving search unit back and forth slightly. See P1 in figure 2.

e. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT height. See figure 2, CRT 1.

f. Mark response on transparent tape covering CRT screen filter using tube type marker.

NOTE

Do not adjust GAIN control settings for remainder of this DAC generation.

g. Remove all couplant in between side drilled hole and location on reference block that is 3 inches from selected side drilled hole.

h. Position search unit approximately 3 inches from selected side drilled hole and peak response of search unit by moving search unit back and forth slightly.

i. Mark response on transparent tape covering CRT screen filter using tube type marker. See figure 2, CRT 1.

j. Connect points on CRT with tube type marker to establish distance amplitude curve (DAC). See figure 2, CRT 1.

17. **Surface Wave Inspection Procedure.**

a. Visually inspect part and record flaws or nonconformities.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to area of part to be inspected.

NOTE

Where grid is required, apply couplant to only one grid block and complete inspection in that area before applying couplant to next grid block.

c. Note dB level selected during DAC establishment and add additional 6 dB sensitivity for scanning. If DAC is not specified in specific work package, add 6 dB to gain established in specific procedure work package.

NOTE

When approaching thickness change, scan toward thicker section if possible. Responses will result from abrupt thickness changes. Scan parallel to radii with sound beam perpendicular to radius to best detect radius cracks.

d. Scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 3 inches in direction of beam centerline between scans. Unless other instructions are specified in specific procedure work package, scan by passing search unit in linear direction while swiveling search unit from right to left with in included angle of 40°. Scan at rate no greater than that established when detecting holes in IIW-2 test block. If grid is required, scan entire area within one grid block before inspecting next grid block.

e. Remove excess couplant in front of search unit, since excess couplant can either damp surface waves or produce responses.

f. Examples of flaw responses are described and illustrated in paragraph 18, CRT Interpretation. If flaw is suspected during scanning, proceed as follows:

(1) Determine response source by finger damping. Place couplant wetted finger, cotton swab, or pencil eraser in front of search unit and move finger, swab, or eraser toward suspected source. Response should decrease in amplitude until finger, swab, or eraser is moved past source.

(2) Peak response from suspected defect by repositioning search unit and/or adding couplant.

(3) Remove 6 dB of additional sensitivity and determine if response amplitude remains equal to or above DAC if DAC curve is being used. When specific work procedure requires DAC, and response is equal to or above DAC, mark part using half amplitude technique described in paragraph 10 and shown in figure 4 to determine flaw boundaries. If response is not equal to or is less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or in specific procedures in structure repair manuals

(A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

18. **CRT Interpretation.**

NOTE

> Always verify source of response. Position couplant wetted finger, cotton swab, or pencil eraser between search unit and suspected response and gradually move finger or cotton swab toward suspected source to damp response. Response should decrease in amplitude until finger, cotton swab, or eraser is moved beyond suspected source. See figure 3, CRT 1.

a. Edge of skin. Figure 3, CRT 2 shows example of response from edge of skin section. As search unit is moved toward edge, response will shift toward initial pulse on CRT horizontal baseline and increase in amplitude.

NOTE

> To continually verify coupling is good, look for responses from natural reflectors such as edges or holes.

b. Holes with or without countersinks. Holes with or without countersinks will produce one response. If hole is near edge, edge response may or may not also be visible on CRT. As search unit is moved toward hole, response will shift toward initial pulse on CRT horizontal baseline and increase in amplitude. See figure 3, CRTs 4 and 5.

NOTE

> Surface protective coatings will also dampen surface waves.

c. Crack responses. Ridges, scratches, cracks, and cracked or chipped paint can often produce responses. Examples are shown in figure 3, CRTs 6 through 10. Back surface response may be visible in addition to crack response. See figure 3, CRT 6. Multiple responses may result from cracks at or near fastener holes, figure 3, CRTs 7 and 8. CRT 9 shows response from crack thickness change. Cracks may also occur at radii in stiffeners, flanges, and steps. Always scan parallel to radii with sound beam perpendicular to radius to best detect radius cracks. See figure 3, CRTs 10 and 11. Crack responses will increase in amplitude and move toward initial pulse as search unit is moved toward crack.

d. Thickness changes. If possible, scan toward thicker sections at thickness changes, since responses can result from thickness changes when approaching thinner sections. See figure 3, CRTs 12 and 13.

e. Responses from radii. Even if there are no cracks or flaws in radius section, responses may result from radius. More than one response may result from different surfaces of radius. For example, responses may result from both surfaces of stiffener. See figure 3, CRTs 14 and 15.

f. Excess couplant. Responses may result from beads of excess couplant on surface, figure 3, CRT 16. Excess couplant can also damp surface waves, resulting in inferior test. Make sure there is no excess couplant in front of search unit.

19. **Half-Amplitude Mapping.**

a. Adjust GAIN so maximum amplitude received from flaw is approximately 95 percent full CRT height. See figure 4, CRT 1.

b. Move search unit parallel to defect while maintaining same sound travel distance. When flaw response amplitude drops to 45 to 50 percent full CRT height, mark part along centerline of search unit. See figure 4, CRT 2. Use this technique to mark both ends of flaw.

20. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to specific procedures in structure repair manuals A1-F18AC-SRM-210 through (A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Define damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

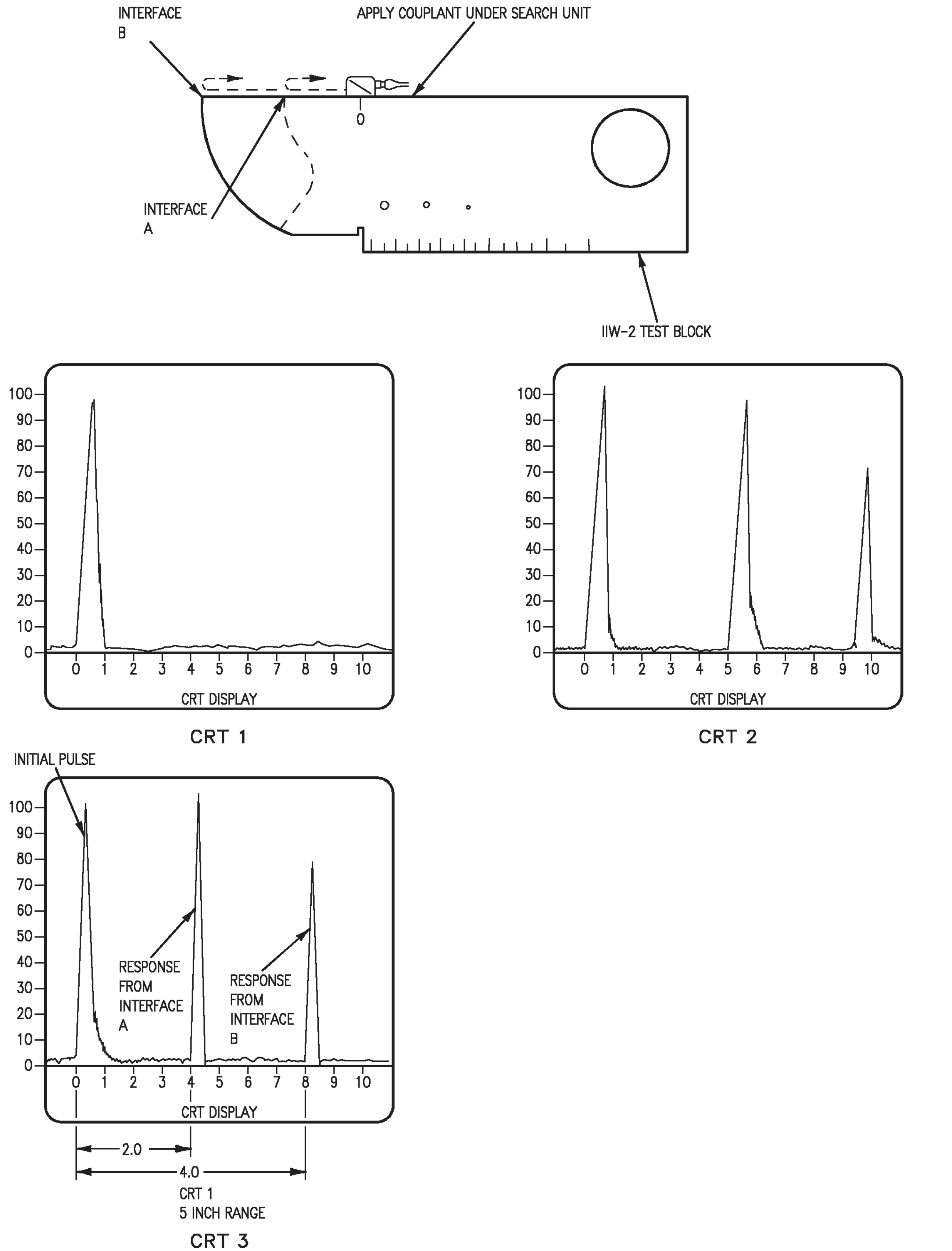
WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

21. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.



18AC-SRM-30-(406-1)31-CATI

Figure 1. Surface Wave Time Base Standardization

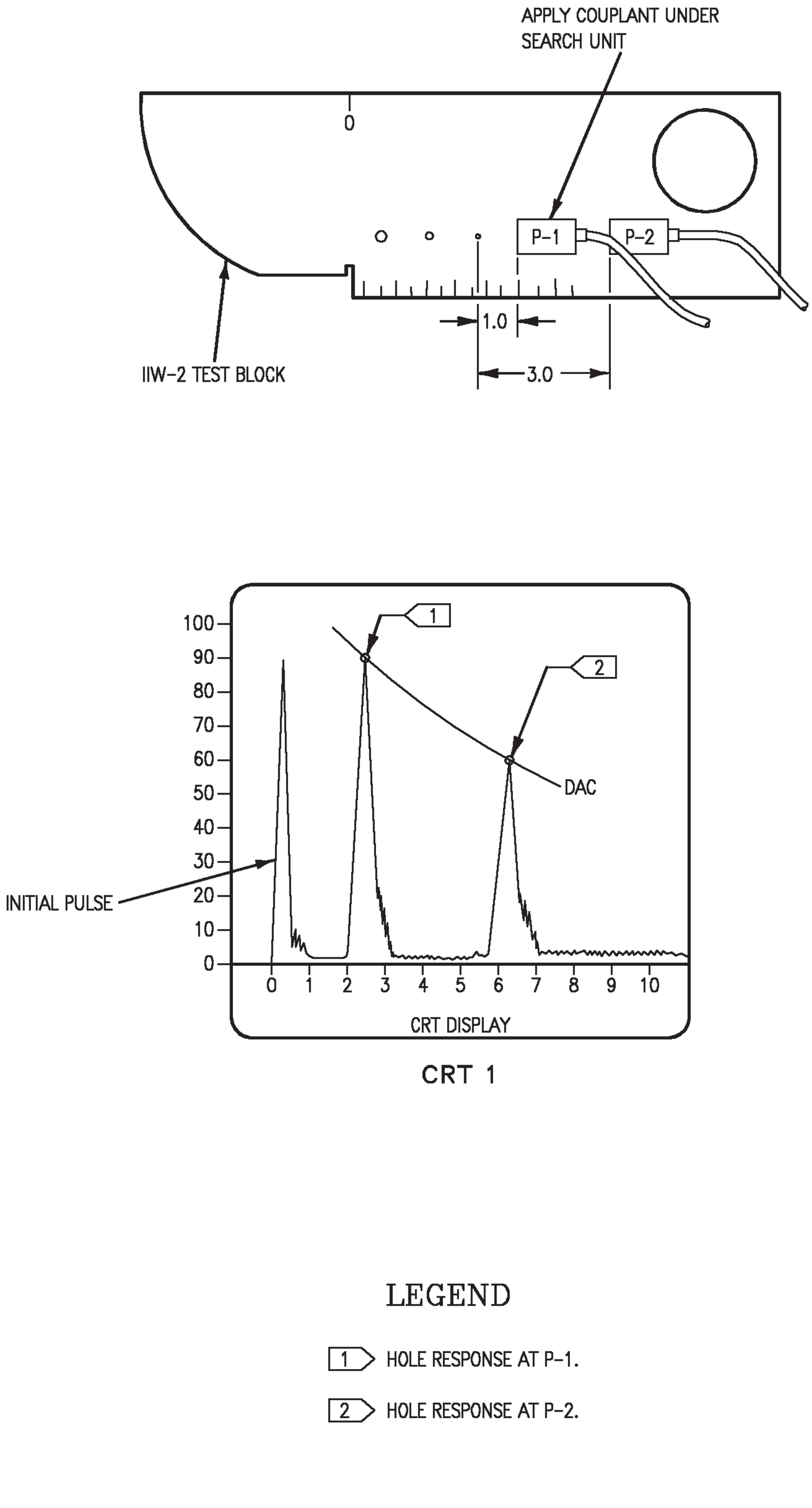
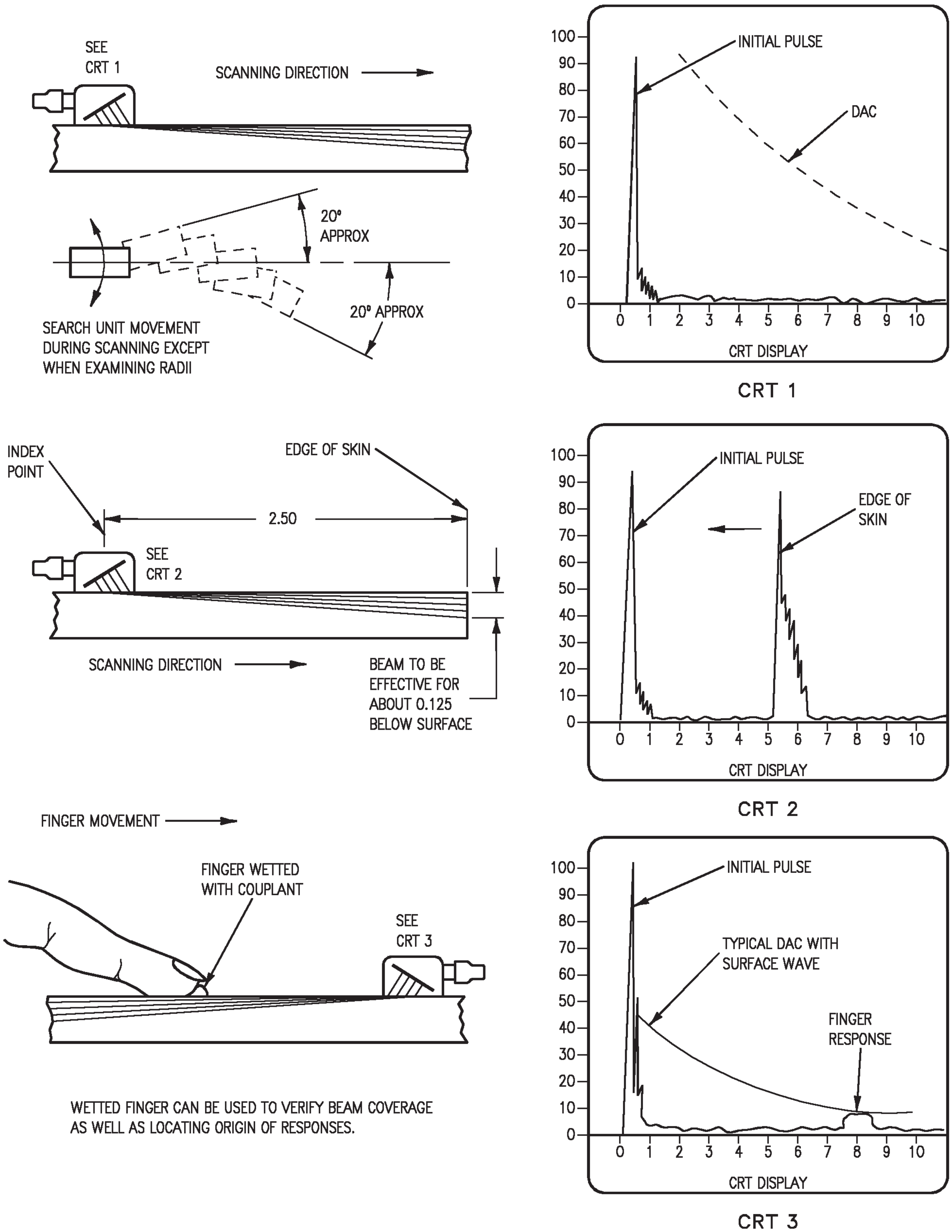
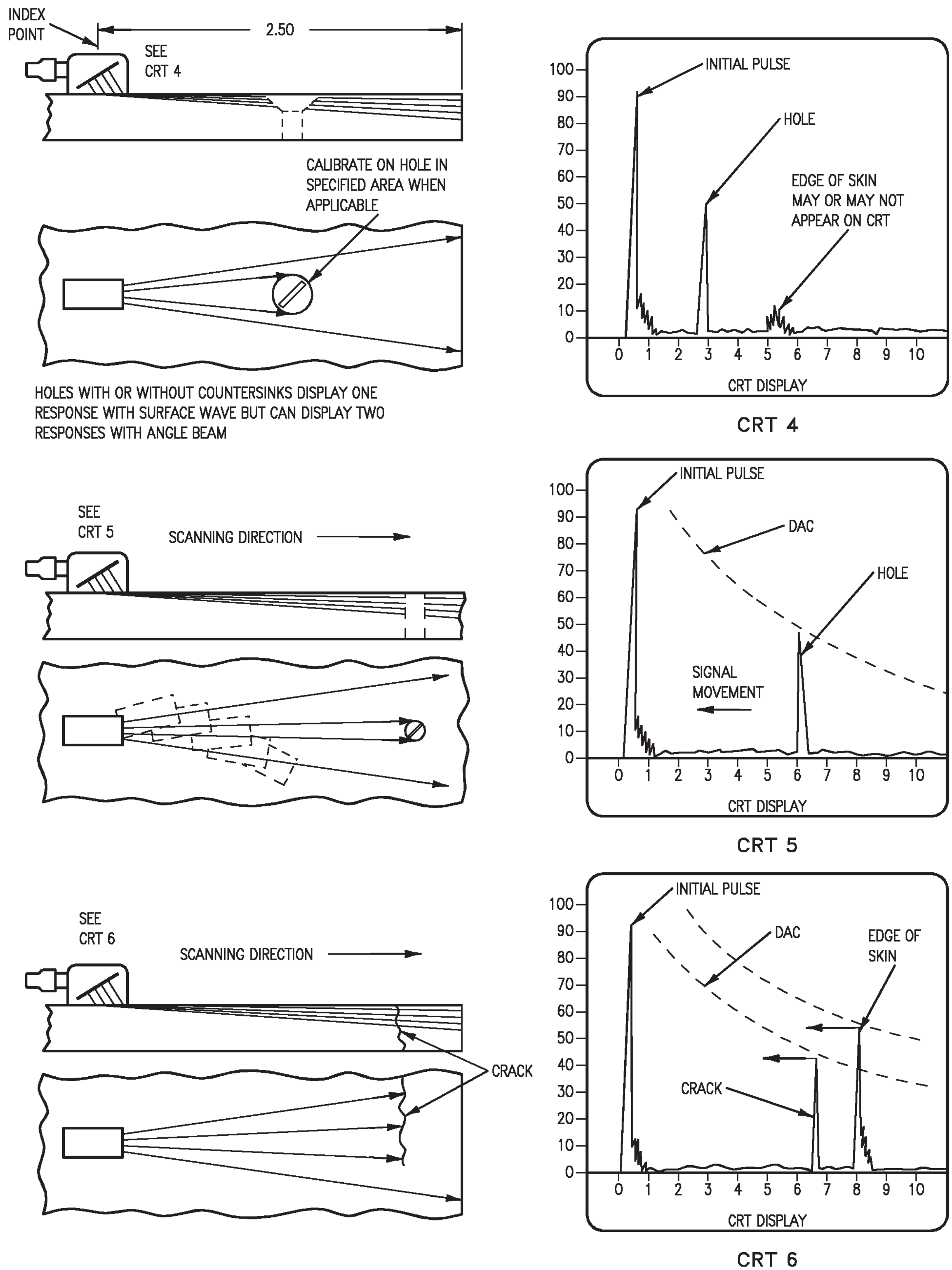


Figure 2. Development of Distance Amplitude Curve (DAC) for Surface Wave Inspection



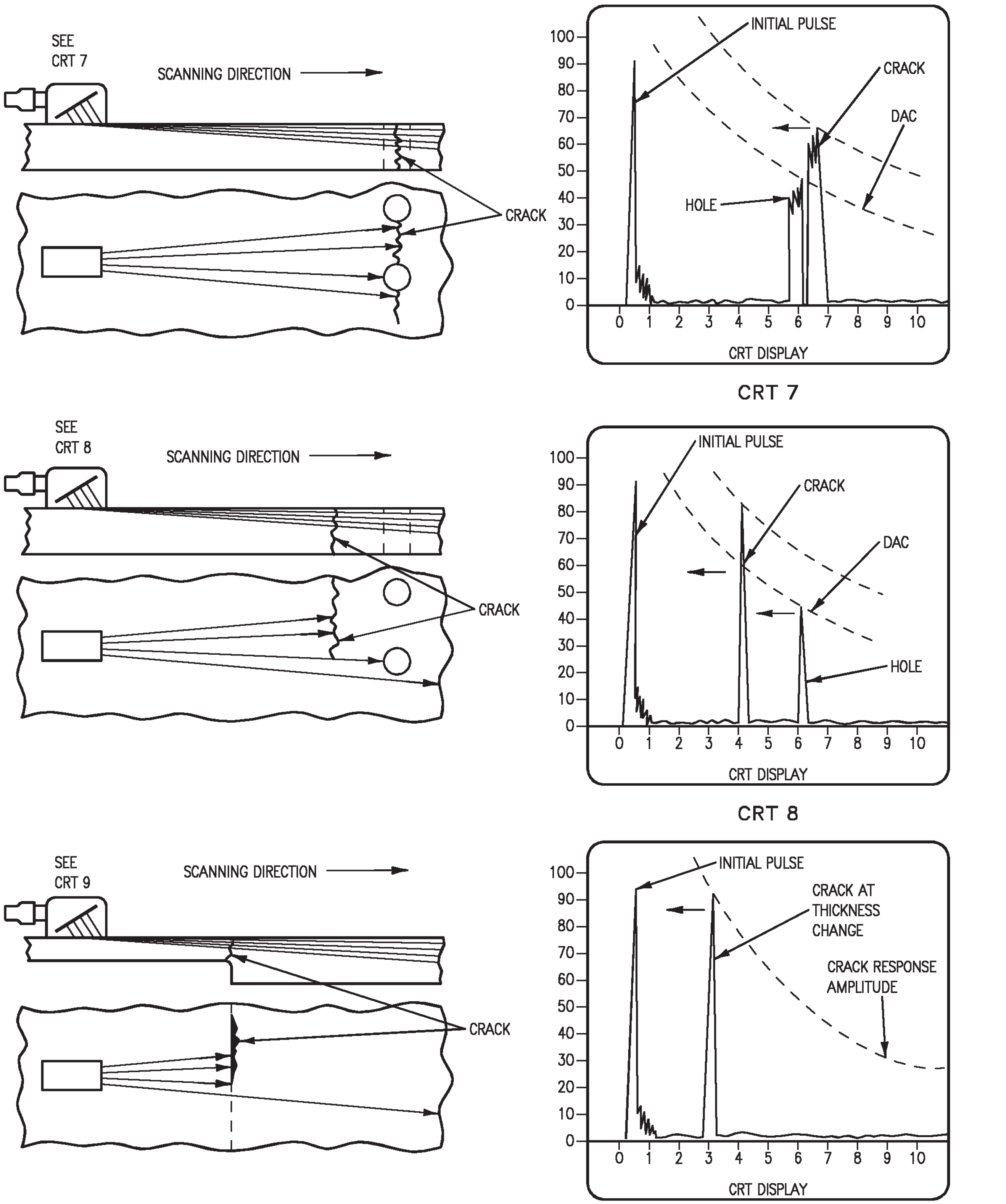
18AC-SRM-30-(408-1)31-SCAN

Figure 3. Typical Responses (Sheet 1)



18AC-SRM-30-(408-2)31-SCAN

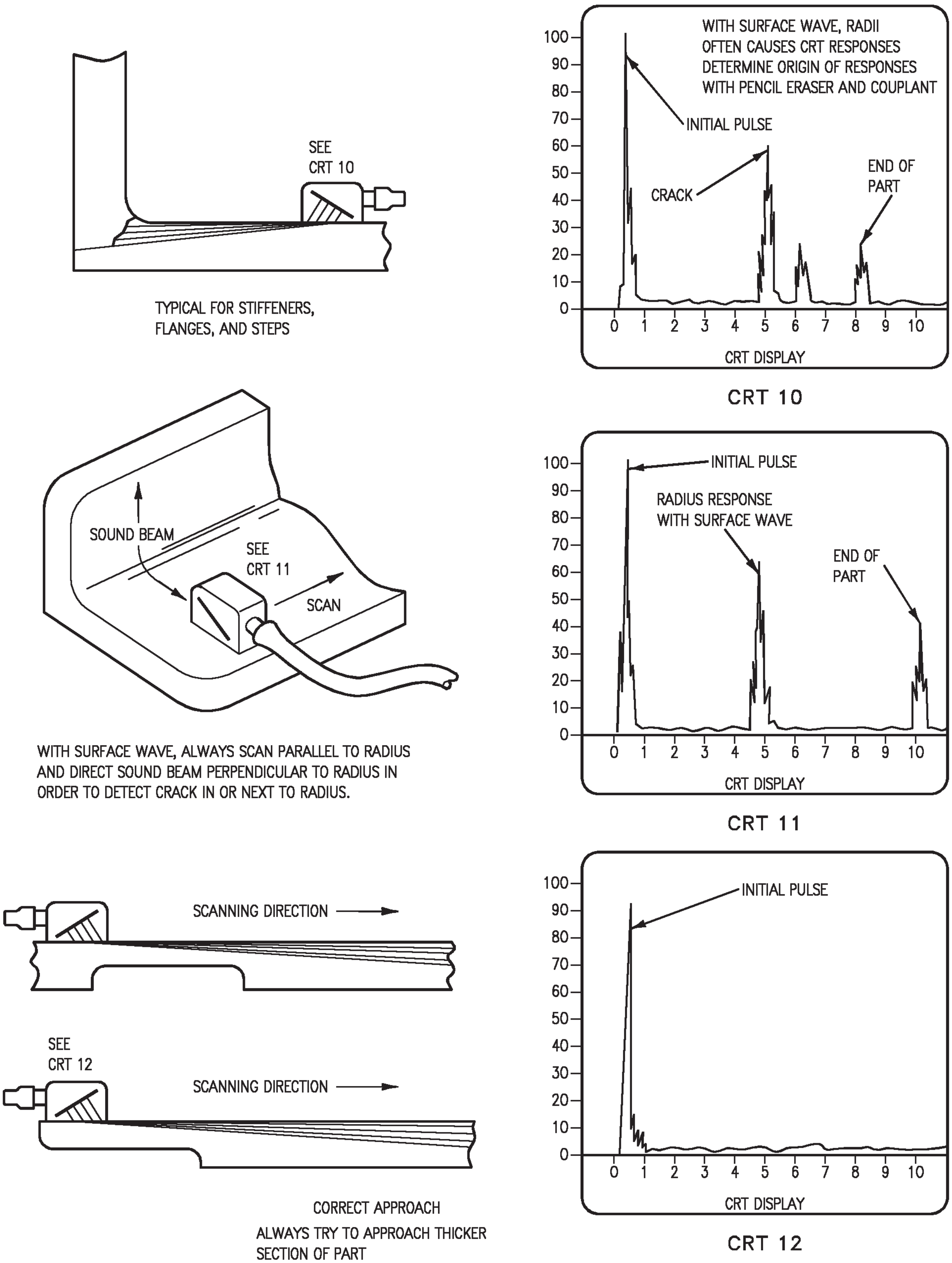
Figure 3. Typical Responses (Sheet 2)



CRT 9

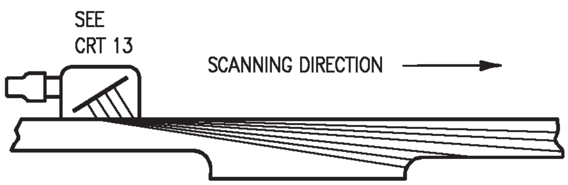
18AC-SRM-30-(408-3)31-SCAN

Figure 3. Typical Responses (Sheet 3)



18AC-SRM-30-(408-4)31-SCAN

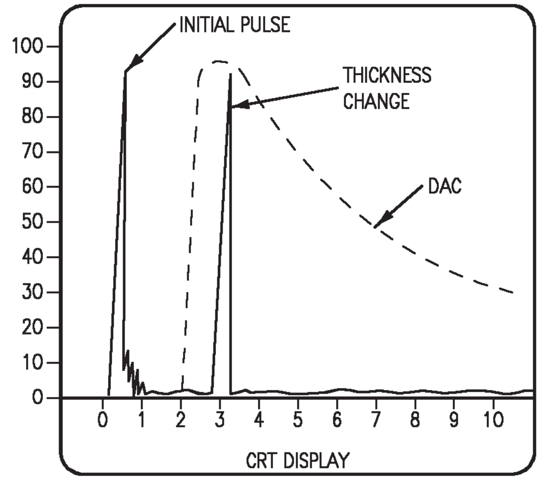
Figure 3. Typical Responses (Sheet 4)



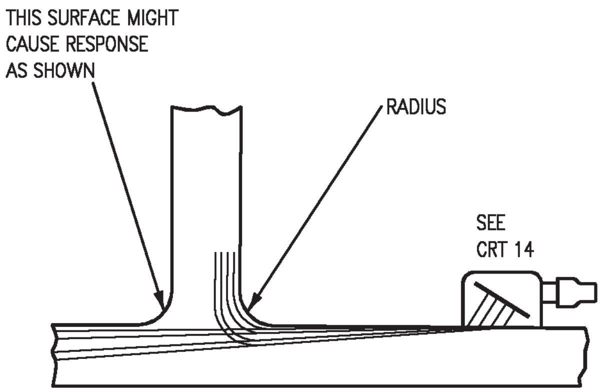
CAUTION

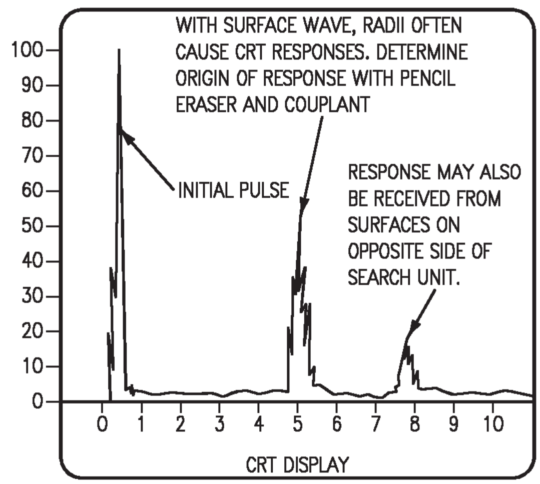
INCORRECT APPROACH

DO NOT APPROACH THINNER SECTION, IF POSSIBLE, BECAUSE RESPONSE WILL BE RECEIVED FROM ABRUPT THICKNESS CHANGE

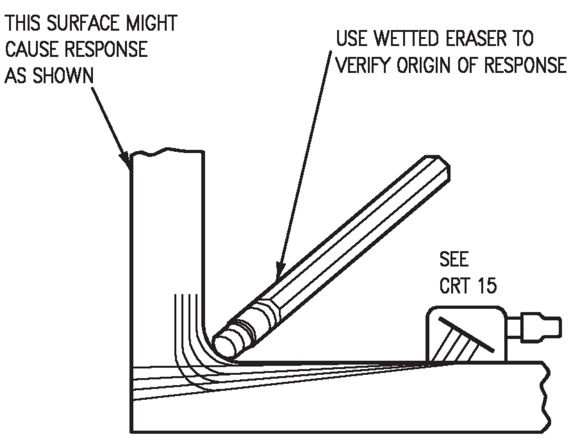


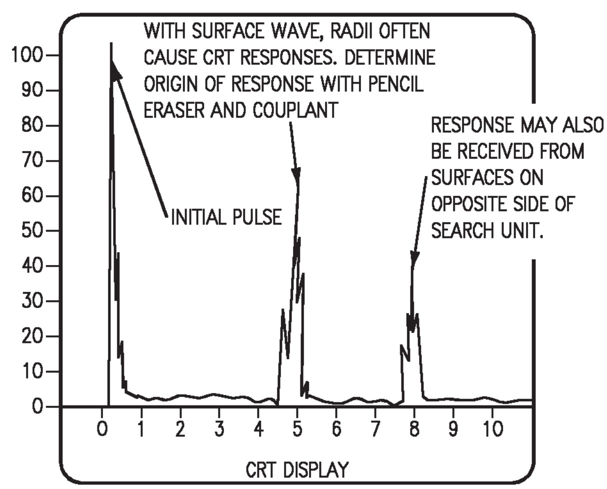
CRT 13





CRT 14





CRT 15

18AC-SRM-30-(408-5)31-SCAN

Figure 3. Typical Responses (Sheet 5)

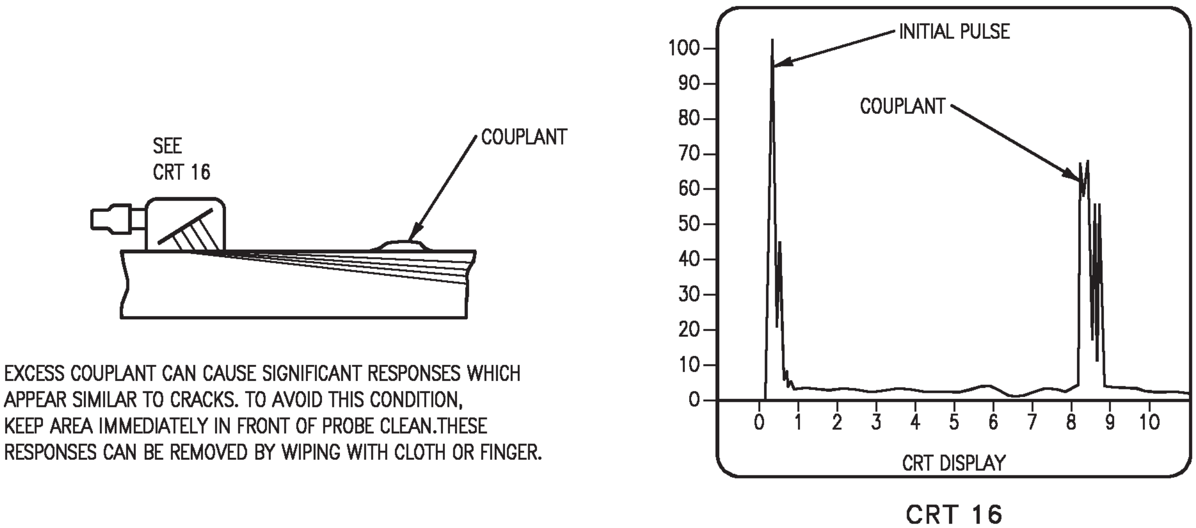
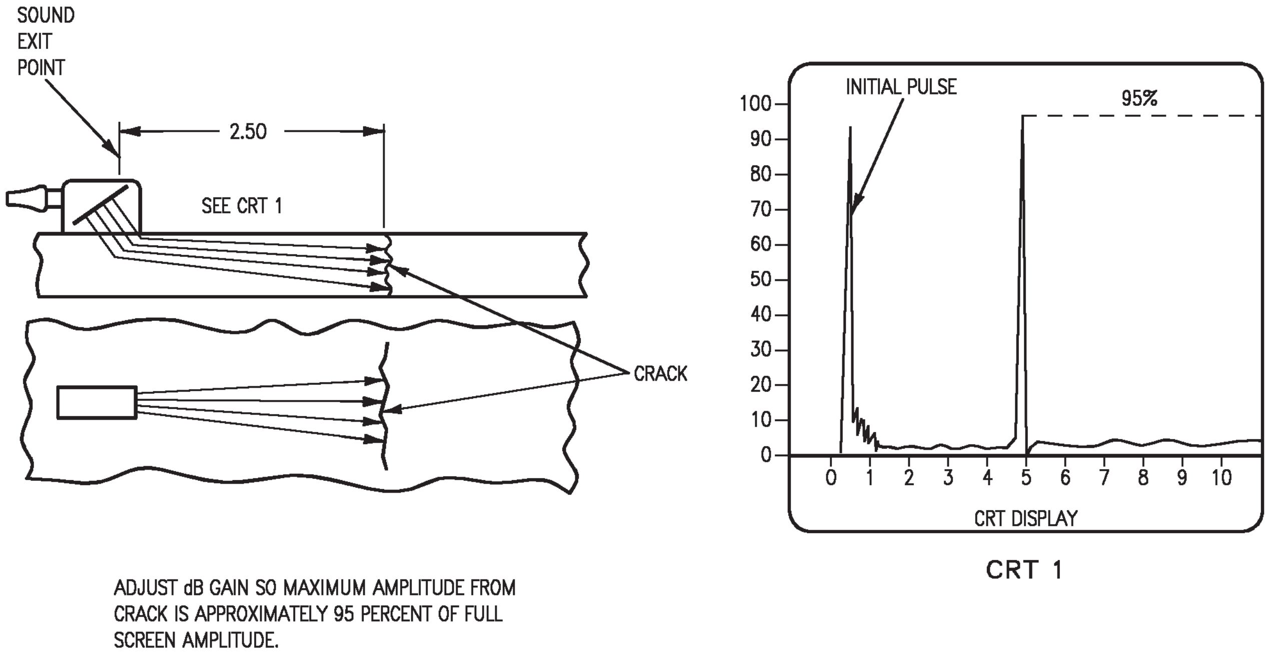
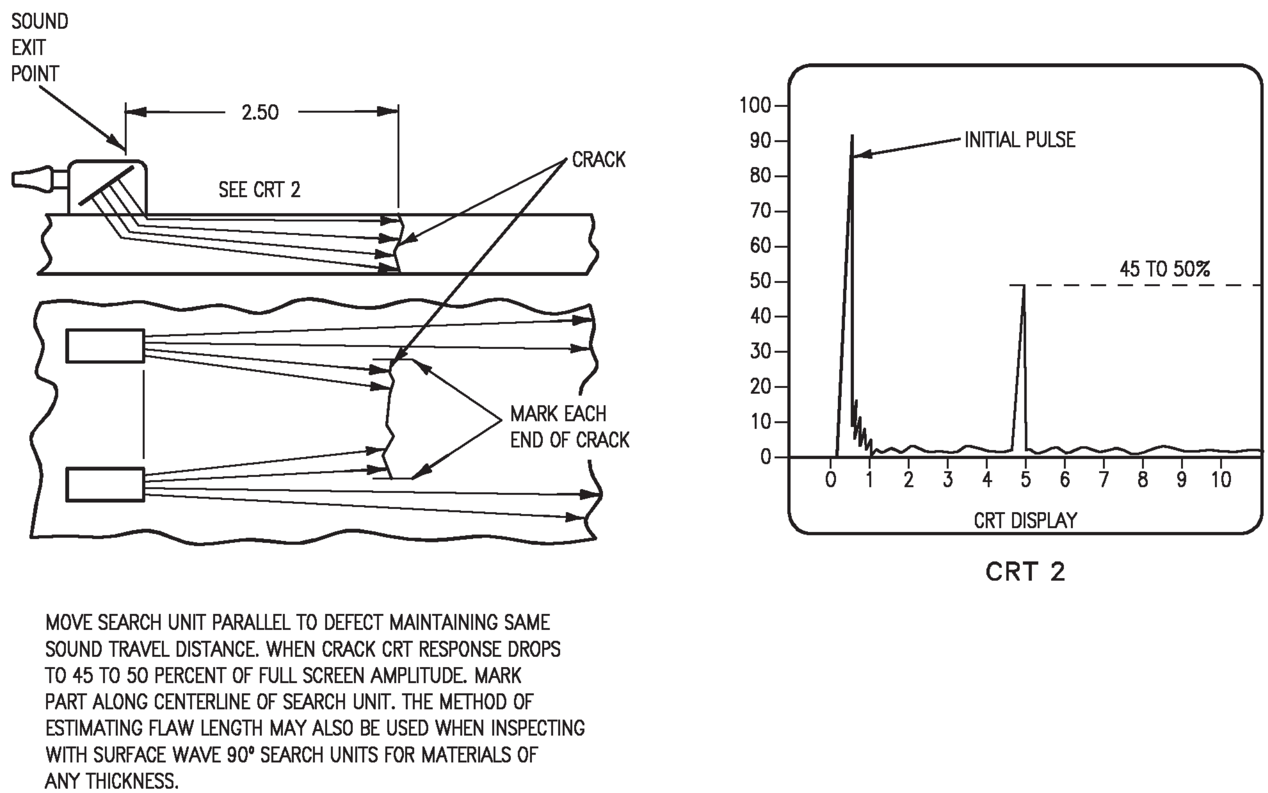


Figure 3. Typical Responses (Sheet 6)





18AC-SRM-30-(409-1)31-SCAN

Figure 4. Half-Amplitude Flaw Measurement

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO LONGITUDINAL, CONTACT THICKNESS INSPECTION OF METALLIC MATERIALS AND COMPOSITE LAMINATES

This WP supersedes WP008 08, dated 1 December 1992.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed, longitudinal, ultrasonic waves are used to inspect composite laminates and metals for thickness. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, time-of-flight, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector. Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Time required for ultrasonic wave to travel through part and back to search unit depends on velocity of ultrasonic wave in material and thickness of part. Therefore, if ultrasonic velocity is known and time-of-flight is measured, thickness of part can be calculated. Magnaflux ultrasonic flaw detector (tester) is equipped with thickness gauge to do this calculation.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Delay Line Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skin for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller
57A4244-30 TYPE 2	IIW-2 Test Block, Aluminum
57A4244-18 TYPE 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/ SETUP, GENERAL.**

a. Connect thickness gauge module to tester using connecting cable.

b. Attach search unit to Microdot connector on connecting cable.

c. Attach BNC end of connecting cable to T or R BNC jack on tester.

d. Turn tester ON, allow 5 minutes warm-up.

e. Turn thickness gauge module POWER switch to ON position.

f. Set tester front face settings;

NOTE

Tester settings are given as an initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	5
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	5
FINE	7.0
POLARITY	+
DISPLAY	GATE
DISTANCE ECHO CORRECTION	OFF

g. Set thickness gauge module face settings initially as follows;

POWER	ON
RANGE (IN.)	RANGE OF MATERIAL TO BE MEASURED
HOLD OFF	ONE TURN FROM FULL CLOCKWISE

6. **CALIBRATION.**

a. Select transducer and reference standard specified in specific work package. If reference standard is not specified, select reference standard close in thickness and composition to inspection area.

NOTE

Metallic wedge may be used, but depth accuracy is lower. Velocity of graphite epoxy is about one half that of aluminum, steel, or titanium. Velocities in graphite epoxy have been found to vary up to ±10 percent, so exact measurements of depth and thickness are not possible.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

It is recommended that this calibration be done on reference standard thickness close to maximum part thickness to be measured.

c. Apply couplant to area of reference standard where thickness is accurately known or can be mechanically measured.

d. Position specified search unit on selected area of reference standard.

NOTE

Initial and response pulses shown in figure may differ from actual wave shape.

e. Adjust HORIZONTAL SWEEP LENGTH and DELAY until three back reflection pulses are visible in addition to initial pulse or first delay line response if delay line is being used. See figure 1, CRT 1.

NOTE

If flaw gage overlaps any part of first back reflection response, thickness measurements will be inaccurate. When this occurs, digital display on thickness gauge module will become erratic. Make sure left edge of flaw gate is not overlapping any part of first back reflection response.

f. Adjust FLAW GATE WIDTH and DELAY controls to position three back reflection pulses within gate notch on CRT. See figure 1, CRT 2. Echoes should have identical characteristics with only difference in amplitude. Initial pulse, or delay line interface if delay line is used, must be outside flaw gate.

NOTE

Always try to use first three responses, not including delay line response. In thin materials, if it is not possible to resolve first three responses, cleanest set of response multiples that can be located should be used.

g. Place VIDEO MODE switch to + and − positions to determine which half cycle has straightest leading edge pulse. Choose this half cycle for analysis.

NOTE

Thickness gauge module cannot compute thickness if second signal within flaw gate is below 40 percent CRT height.

h. With search unit coupled to reference standard, adjust GAIN so amplitude of second back reflection is greater than 60 percent CRT height and third back reflection is greater than 40 percent CRT height. At this GAIN setting, it is acceptable for amplitude of first back reflection to be greater than 100 percent CRT height. GAIN adjustment is critical to get correct and accurate thickness measurements. See figure 1, CRT 3.

i. If there is ringing on first response leading edge crossing threshold, ringing on second and third response leading edges must also cross threshold for accurate measurement. If not the case, reduce GAIN until leading edge ringing on both responses is below threshold level. See figure 1, CRTs 4 and 5.

NOTE

For thin materials, use caution to avoid making measurements when receiver is saturated. Indication of saturation is when gain is increased and peaks of responses decrease in amplitude. Reduce GAIN until receiver is no longer saturated when this occurs.

j. Adjust thickness module VELOCITY control until thickness module displays actual reference standard thickness. If reading does not appear, or if display is erratic, adjust HOLD OFF control until display reading appears and is stable.

k. Thickness gauge is now adjusted for direct read-out of thickness of display.

7. THICKNESS MEASUREMENT PROCEDURE.

NOTE

Surface finish of part will affect accuracy of readings.

Table 1. Thickness Measurement Error Due to Surface Roughness of Reference Standard or Test Part

Surface Finish (rhr)	Measurement Error (Inches ±)
0-63	0.0005
63-125	0.002
125-250	0.005
500-500	0.010
500-20000	0.020

a. For measurements with maximum accuracy, all foreign material which may interfere with

thickness measurement should be removed. Examples of such material are loose scale, paint, and rust. The specific work package procedure will include details on removal of paint, or on other inspection reparation required for areas to be inspected.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to inspection area. If large area is to be inspected, apply couplant to one small area to avoid couplant evaporation.

d. Scan inspection area for minimum thickness required per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. Specific procedure work package should list thicknesses required for inspection area(s).

e. Record thicknesses measured per instructions in specific procedure work package.

f. Unless other procedures are listed in specific procedure work package, mark areas that fall below minimum thickness using aircraft marking pencil and be sure to record thicknesses measured in these areas.

g. Some conditions and response settings that may create false or erratic readings are describe in paragraph 8.

8. **TROUBLESHOOTING.**

a. Inspection of thin areas. When delay line is being used, paint and part curvature may cause delay line interface signal to be wider than during standardization. If measuring thicknesses of approximately 0.075 or less, delay line interface and first back reflection may be so close together due to width of delay line interface signal, that correct placement of left edge of gate notch may be difficult and/or thickness gauge module will be unable to display stable and accurate thickness measurement. See figure 2, CRT1. To enable wall thickness determination under this condition, one or both of following adjustments should be made.

(1) Adjust REJECT control to suppress low amplitude signals and possibly create separation between delay line interface and first back reflection response. This will enable left edge of flaw gate to more easily be positioned. See figure 2, CRT 2.

(2) Adjust flaw gate delay to move left edge of flaw gate between first back reflection and second back reflection responses, so thickness measurement is made using second and third back reflections instead of first and second back reflection pulses. See figure 2, CRT 3. If neither of these adjustments works, specific work procedure may give other instructions such as removing paint from inspection area.

b. False measurements due to wide spacing of spikes in first response. Sometimes spikes of first pulse in flaw gate will be spaced just far enough apart that measurement will be made between these two spikes of first pulse instead of between first two pulses in flaw gate. If this occurs, thickness reading will obviously be low and incorrect. See figure 3, CRT 1. There are several options that may be used to resolve this condition:

(1) Adjust HORIZONTAL SWEEP LENGTH knob to decrease width of signal and change FILTER to decrease width of signal and tie various spikes together. Only use minimum setting of FILTER to create this effect. See figure 3, CRT 2.

(2) Switch VIDEO MODE control to either positive or negative, see figure 3 CRTs 3 and 4.

c. Increased baseline noise. If delay line is being used, examine face of delay line to see if edges are

chipped, face is worn unevenly or face has deep scratches. Examine interior volume of delay line by holding it up to light and check for fine cracks. Replace delay line if any of these conditions are present.

9. **ACCEPTANCE CRITERIA.**

a. Acceptable thickness and/or damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to specific procedure in structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for the inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

10. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to dry for 15 minutes after cleaning.

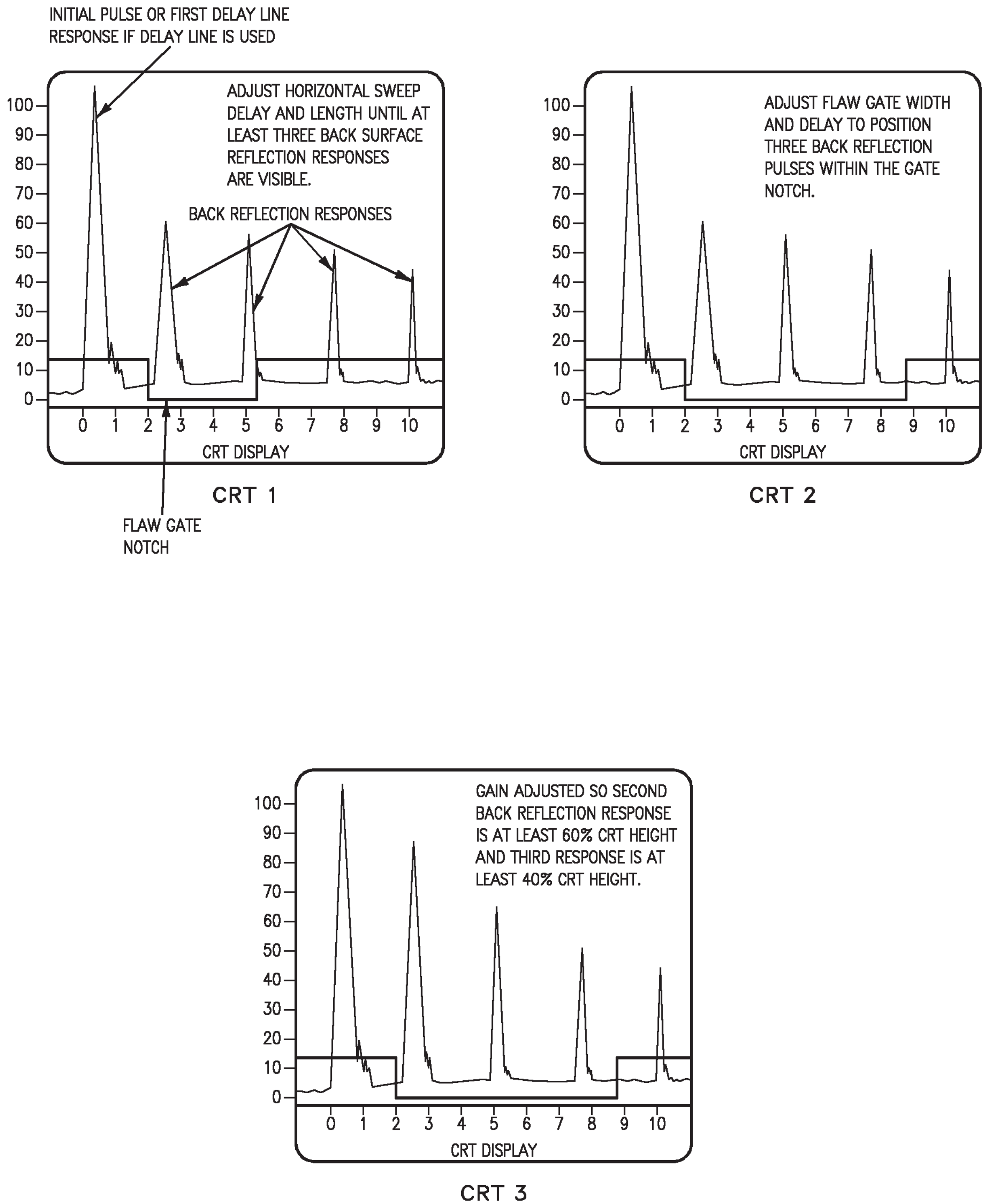
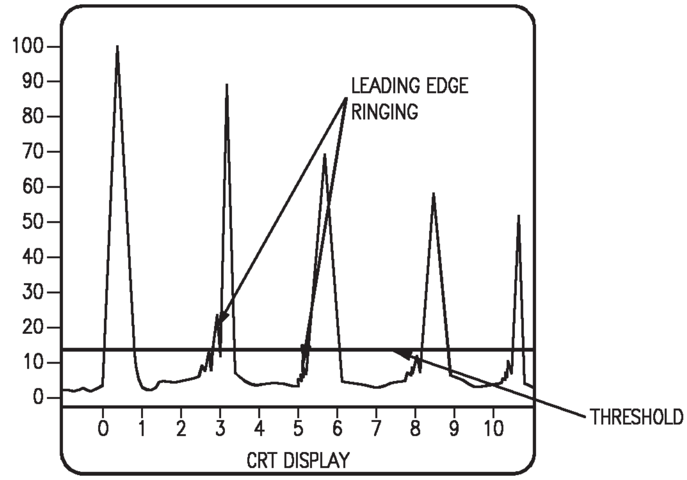
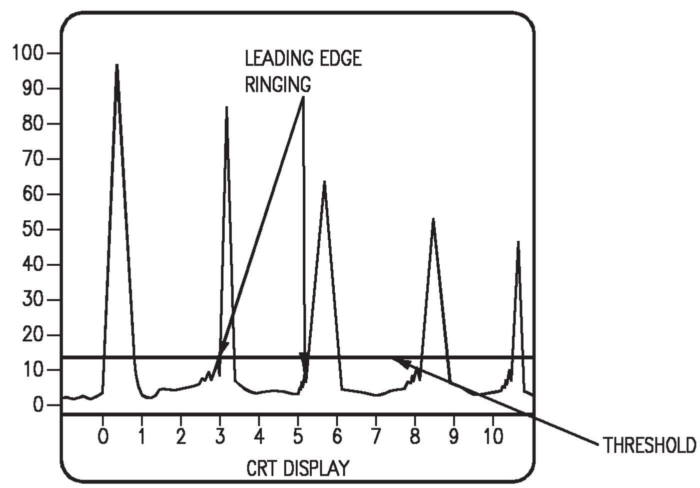


Figure 1. Calibration Responses (Sheet 1)



CRT 4

INCORRECT MEASUREMENTS WILL RESULT SINCE RINGING CROSSES THRESHOLD ONLY ON FIRST BACK REFLECTION RESPONSE.

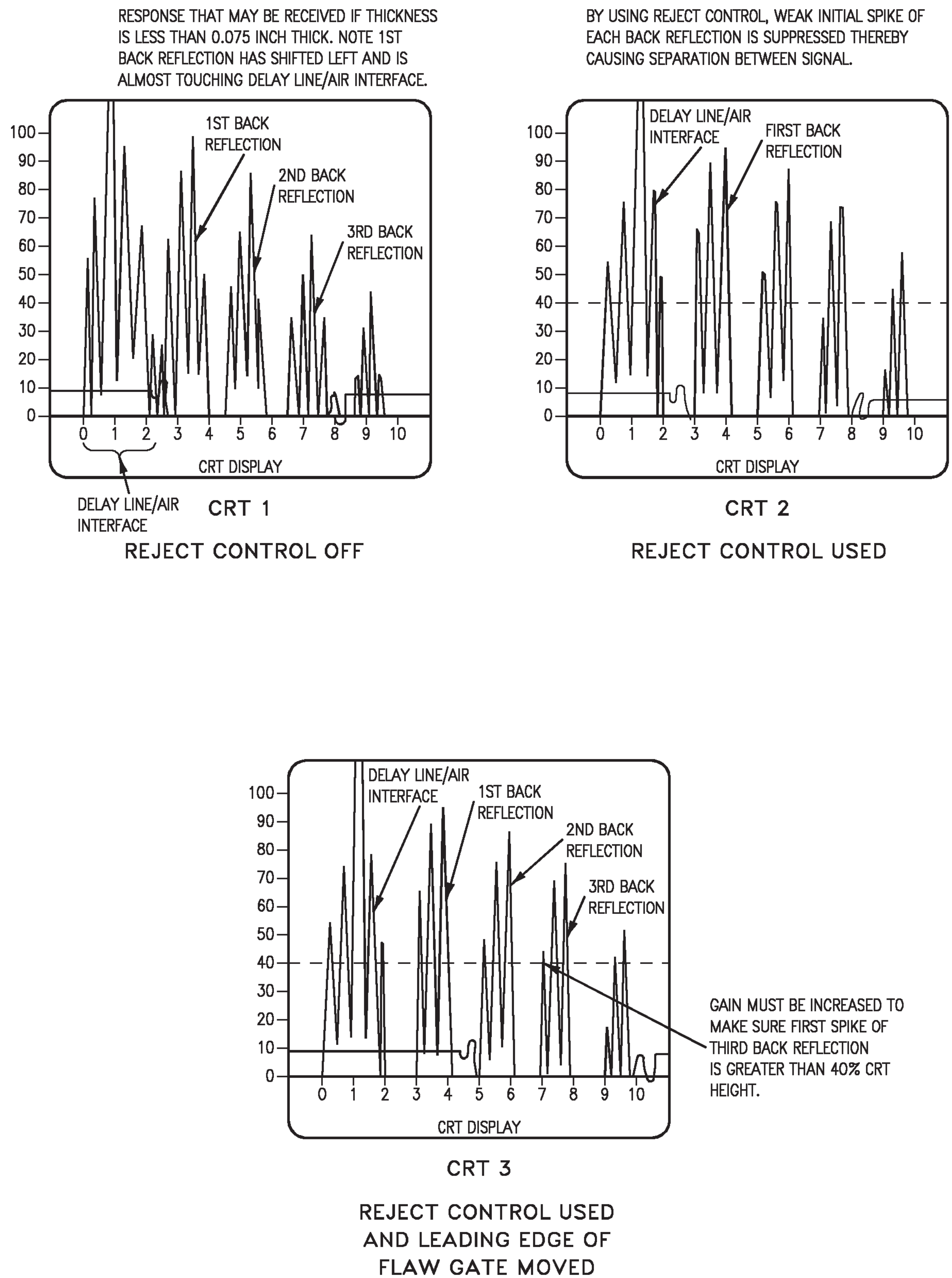


CRT 5

GAIN REDUCED SO LEADING EDGE RINGING ON ALL RESPONSES IS BELOW THE THRESHOLD.

18AC-SRM-30-(395-2)31-SCAN

Figure 1. Calibration Responses (Sheet 2)



18AC-SRM-30-(396-1)31-SCAN

Figure 2. Trouble shooting-Use of Reject Control

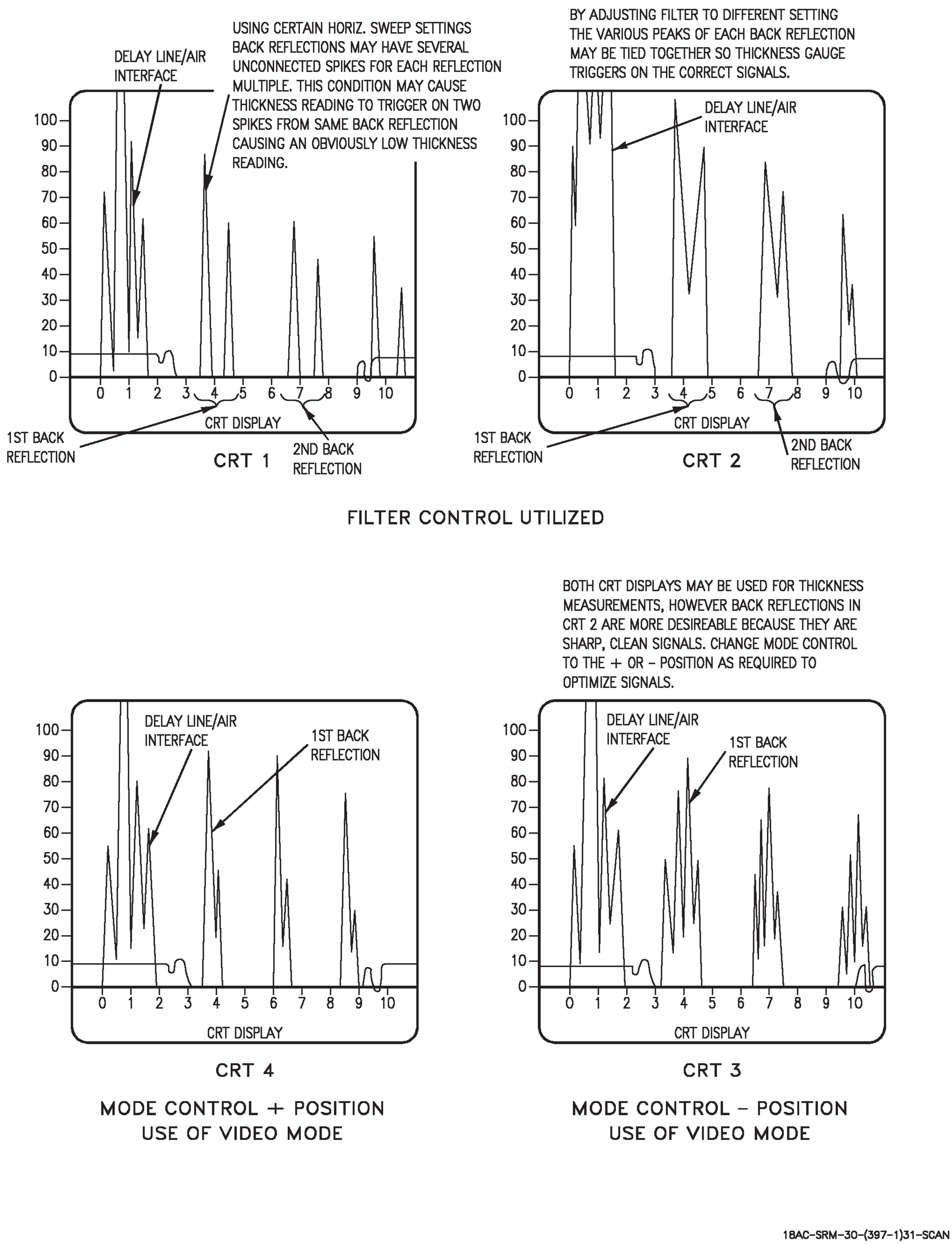


Figure 3. Trouble shooting-Use of Filter

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

ULTRASONIC THROUGH TRANSMISSION CONTACT TESTING, STANDARDIZATION, AND INSPECTION PROCEDURES FOR COMPOSITE LAMINATE AND METALLIC SKINS BONDED TO HONEYCOMB CORE

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Subject	Page No.

Record of Applicable Technical Directives

None

1. **ULTRASONIC INSPECTION.**

2. Ultrasonic waves are used to inspect composite and metallic skin to honeycomb bond line integrity. In through transmission mode, transmitting search unit, or transducer, introduces sound into part and sound beam is detected by receiving search unit on opposite face of part. Positive response, sensed by receiving search unit, indicates continuous sound path, which is used to verify test area is free from defects within limits of test. Interruptions in sound path by complete blockage, 100 percent signal loss, or large signal reduction indicates presence of defect(s) or materials which cause changes in acoustic properties.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI TECHNICIANS, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable, two Reqd
57A2214 or EQUIVALENT	0°, 0.250 Dia, 5 MHz, Contact Delay Line Search Unit, two Reqd
74D110175-1001	Graphite Epoxy Reference Standard Set
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth
DISTILLED WATER COMMERCIAL (O-C-265)	Distilled Water

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cables.

b. Attach BNC end of connecting cables to T and R BNC jacks on ultrasonic flaw detector (tester).

c. Turn tester ON, allow 5 minutes warm-up.

d. Set tester front face settings;

NOTE

Tester settings listed here are given as initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN.
FREQ	SAME AS SEARCH UNIT
MODE	THRU
GAIN (dB)	60 (dB)
COURSE GAIN	6
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	5
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	1
FINE	7.0
POLARITY	OFF
DISTANCE ECHO CORRECTION	OFF

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water or cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material. Inspection area(s) is free of contamination or foreign material.

f. Allow to air dry for 15 minutes after cleaning.

g. With search units held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline.

h. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

CAUTION

Do not use grease pencil or otherwise mark on face of CRT filter. Damage to components will occur.

6. **STANDARDIZATION AND INSPECTION OF 1 INCH OR LESS HONEYCOMB CORE SANDWICH ASSEMBLIES.**

7. **Standardization for 1 Inch or Less Honeycomb Core Sandwich Assemblies.** See figure 1. Use 74D111295-1005 honeycomb reference standard set. Which is part of 74D110175-1001 graphite epoxy reference standard set, to complete this standardization.

NOTE

Initial and response pulses shown in figure may differ from actual wave shape.

a. Start with tester front face settings as in paragraph 5, step d. With search units in air or face up on work surface, initial pulse leading edge should be located at zero on CRT horizontal baseline. See figure 2, CRT 1.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to both surfaces of reference standard at calibration point P-1 or P-2 specified in specific procedure work package. See figure 1.

c. Position search units on both surfaces of reference standard at calibration point.

NOTE

If search units are slightly misaligned, received response will be reduced in amplitude and leading edge will be shifted toward 10 on CRT horizontal baseline. See figure 2, CRT 3.

d. Adjust GAIN, HORIZONTAL SWEEP FINE LENGTH, DAMP., AND REJECT to locate leading edge of received response at 4 on CRT horizontal baseline and peak amplitude at 80 to 90 percent CRT height. See figure 2, CRT 2. Make sure search units are correctly aligned by maximizing response height.

e. Adjust FREQ, FILTER, GAIN, and VIDEO DISPLAY to optimize CRT response if required.

f. Position search units on 1.00 inch diameter crushed core area of reference standard next to specified calibration point and observe reduction in received response or complete loss of received response. See figure 2, CRT 4. If search units are not completely on defective area, response will be received, but leading edge will be shifted slightly toward 10 on CRT horizontal baseline. Leading edge of initial pulse should still be located at zero.

NOTE

During inspection, step g. may be done for suspect areas. In this case, do substep (1) on known good area, move search units to suspect area to do substep (2). Move search units back to known good area to do substep (3), and return search units to suspect area to do substep (4).

g. During inspection more gain may be required for configuration penetration because of extra adhesive, wrinkled honeycomb core, or crushed honeycomb core. Do following sequence to observe good and bad responses relative to setup point:

(1) Position search units back on specific work package calibration point and reproduce through transmission response with peak amplitude at 80 to 90 percent CRT height. See figure 2, CRT 2.

(2) Adjust COARSE/FINE GAIN to decrease gain by 6 dB and observe reduction in received response peak. See figure 2, CRT 5. Even with this reduction in gain, received response should be greater than 10 percent CRT height if area is good.

(3) Adjust COARSE/FINE GAIN to add 6 dB, returning received response to 80 to 90 percent CRT height. See figure 2, CRT 2.

(4) Adjust COARSE/FINE GAIN to add additional 6 dB of gain and observe an increase in received response amplitude. Response should saturate or be greater than 100 percent CRT height if area is good. See figure 2, CRT 6. If area contains crushed core, received response will be less than 5 percent CRT height even with this 6 dB gain added. See figure 2, CRT 7. If search units are on edge or an area containing crushed core, reduction in amplitude combined with shift in time of response leading edge toward 10 on CRT horizontal baseline will be observed. See figure 2, CRT 8.

8. **Inspection of 1 Inch or Less Honeycomb Core Sandwich Assemblies.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.

c. To be sure of full inspection coverage, mark 3.00 X 3.00 grid pattern on both surfaces of inspection area using aircraft marking pencil. Make sure grid patterns on both surfaces are correctly aligned with each other.

d. Apply couplant to both surfaces of inspection area.

NOTE

Initial search unit alignment may be established by maximizing signal response. Search unit alignment must be maintained during inspection. See figure 3 for example of search unit alignment device. Alignment yokes are commercially available.

e. Position search units on both surfaces of inspection area where core height is 1.00 or less.

NOTE

Response from structures consisting of metallic skins bonded to honeycomb core will differ from structures with composite laminate skins.

f. Adjust GAIN to set peak amplitude of received response at 80 to 90 percent CRT height. See figure 4, CRT 1. Make sure inspection area core thickness does not exceed 1.00 inch. As core thickness increases, received response location will move toward 10 on CRT horizontal baseline. See figure 4, CRTs 2 and 3.

g. Using through transmission, scan both surfaces of inspection area. Scan each grid block before moving to next. Be sure to maintain search unit alignment.

h. Use aircraft marking pencil to mark all areas where through transmission response peak drops below 5 percent CRT height, even with addition of 6 dB of gain, or if leading edge of received response is shifted 1 major division toward 10 on CRT horizontal baseline. The 6 dB of gain must be made relative to nearby good area or previously determined good bonded area. Refer to step g. of paragraph 7 for details on interrogating suspect area. Flaw response is similar to figure 2, CRTs 3, 7, 8, and figure 4, CRT 4.

i. Once flaw has been identified, use half amplitude mapping technique described in paragraph 16 to determine size of flaw.

j. Use radiographic method (WP005 00) to determine if above marked area is result of additional adhesive, core splice, or extra layer of foaming adhesive. Radiographs of foaming adhesive and core splices are contained in (WP005 00). Ultrasonic reference standard used to set up this inspection contains an extra layer of foaming adhesive and core splice which may be radiographed and used as a guide.

9. **STANDARDIZATION AND INSPECTION OF 1 TO 2 INCHES HONEYCOMB CORE SANDWICH ASSEMBLIES.**

10. **Standardization for 1 to 2 Inches Honeycomb Core Sandwich Assemblies.** Use 74D111295-1003 honeycomb reference standard set, which is part of 74D110175-1001 graphite epoxy reference standard set, to complete standardization. Follow standardization procedure listed in paragraph 7 except start with horizontal sweep coarse length at 2.

11. **Inspection of 1 to 2 Inches Honeycomb Core Sandwich Assemblies.** Follow inspection procedure described in paragraph 8 with following exceptions:

a. Make sure inspection area remains within 1 to 2 inch range.

b. Use aircraft marking pencil to mark areas where leading edge response falls below 5 per cent CRT height or is shifted more than 1 large division on CRT horizontal baseline toward 10.

12. **STANDARDIZATION AND INSPECTION OF 2 INCHES OR TALLER HONEYCOMB CORE SANDWICH ASSEMBLIES.**

13. **Standardization for 2 Inches or Taller Honeycomb Core Sandwich Assemblies.** Use 74D11295-1001 graphite epoxy reference standard set, to complete standardization. Follow standardization procedure listed in paragraph 7 except start with horizontal sweep coarse length at 5.

14. **Inspection of 2 Inches or Taller Honeycomb Core Sandwich Assemblies.** Follow inspection procedure described in paragraph 8 with following exceptions:

a. Make sure inspection area does not exceed 6 inches in thickness.

b. Use aircraft marking pencil to mark areas where leading edge response falls below 5 percent CRT height or is shifted more than 1/2-large division on CRT horizontal baseline toward 10.

15. **CRT INTERPRETATION.**

NOTE

Make sure of coupling and search unit alignment before marking area as defect.

a. Crushed core. Presence of crushed core will result in absence of received response or large reduction in received response. See figure 2, CRT 4. If search unit does not completely cover area containing crushed core, response will be reduced in amplitude and shifted to left on CRT horizontal baseline. See figure 2, CRT 8.

b. Skin to core unbond. Presence of skin to core unbond will result in complete loss of received response or response less than 5 percent CRT height even when 6 dB of gain has been added compared to P-1 or P-2 calibration point response with 80 to 90 percent CRT height amplitude. See figure 4, CRT 4.

c. Thickness change. As search units are moved across area in which core height is increasing, response will move toward left on CRT horizontal baseline. See figure 4, CRTs 2 and 3.

d. Search unit misalignment. When search units become slightly misaligned, response will be reduced in amplitude and shifted to left on CRT horizontal baseline. See figure 2, CRT 3.

16. **HALF AMPLITUDE MAPPING.** Map defects larger than base of largest search unit used in inspection as follows;

a. Mark preliminary flaw outline where received response falls below 5 percent of level established in inspection procedure. Map size of flaw(s) as follows:

(1) Verify coupling and correct equipment operation.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

(2) Clean off excessive or dried couplant and reapply minimum of new couplant.

(3) To map edge of defect(s) larger than search unit face, move search unit slowly toward edge of defect until response from nearby good bond area decreases in height to about 1/2-CRT height. See figure 5, CRTs 1 through 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 5.

(4) Make mark on surface of part being inspected at centerline of search unit. Continue mapping edges of defect until defect area is drawn out on part surfaces. When unbond is detected, length and width dimensions of unbond should be determined during mapping.

b. Make sure search units are aligned during mapping. Slight shift or misalignment may cause inaccurate mapping.

(1) Use radiography to determine presence of previous repairs or extra adhesive.

17. **EVALUATION OF DAMAGED AREAS.** Evaluate damage to composite skins bonded to honeycomb core as follows:

a. Evaluate skin to core bonded areas per applicable paragraphs 5 through 15.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Use either couplant listed in this work package or use distilled water as couplant.

c. In localized indentations, surface contours at localized indentations may make coupling of search units impossible. Smaller diameter search units with same or different frequencies may be used to scan indentation. See figure 6.

d. Local indentations may also contain crushed core. See figure 6. It may be required to increase gain because of attenuation effects of crushed core.

e. Scan at least 2.00 to 3.00 inches around visible outer edge of damage to make sure any subsurface damage is detected.

NOTE

Patch may already be bonded to damaged assembly.

f. Radiography may be required to detect subsurface crushed core and laminate cracks or to identify any additional adhesive or inconsistent materials detected during ultrasonic inspection.

g. Refer to specific repair work package for patch diameter determination (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

h. If patch diameter exceeds step e. inspection data, do step i.

i. Scan area around outer edge of damage, up to diameter of patch. This will make sure subsurface conditions do not interfere with repair evaluation.

18. **REPAIR EVALUATION.**

a. Evaluate repair of skin to core bonded areas per applicable paragraphs 5 through 15.

b. Use search units specified in this work package or other large diameter search units, up to 1/2-inch diameter with same, higher, or lower frequency.

c. Additional GAIN may be required to penetrate repair area, because repairs usually contain extra adhesive, 1 or more layers of film adhesive, and bonded on patches.

d. After setting time base with HORIZONTAL SWEEP LENGTH, and after setting through transmission received response amplitude with GAIN, using specific reference standard, position search units on patch area near repair. See figure 7.

e. Use GAIN to set received response amplitude at 80 to 90 percent CRT height.

f. Position search units on repair area and adjust GAIN so received response is at 80 to 90 percent CRT height. Up to 32 dB of GAIN may be added to step e. settings. Make sure search units are correctly aligned by maximizing received response.

g. Inspect repair and surrounding patch area. Mark all areas where received response falls below 5 percent CRT height even after 32 dB gain has been added.

h. Use radiographic method (WP005 00) to inspect area 6.00 inches out from patch periphery for core damage. Inspect same area using through transmission, this work package, to inspect for skin to core unbonds, blown core, or delaminations caused by repair. See figure 8.

19. **ACCEPTANCE CRITERIA.**

20. **Honeycomb Core Sandwich Assemblies Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If information is not included in specific work package, refer to specific work packages in structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of

flaws per area, and criteria for delaminations that overlap zones/areas on part.

21. **Patch Bond Line Flaw Acceptance Criteria.**

a. Flaw/unbond is measured along radial line from center of repair patch. See figure 8.

b. Allowable unbond in patch to core area is determined from repairable unbond criteria of specific procedure work package for part or assembly being replaced.

c. Patch to skin bond area, total flaw/unbond length along any radial line must not exceed 0.31 inch.

d. For multiple flaws, not on same radial line, total flaw area must be 20 percent or less than total patch to skin bond area.

22. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.

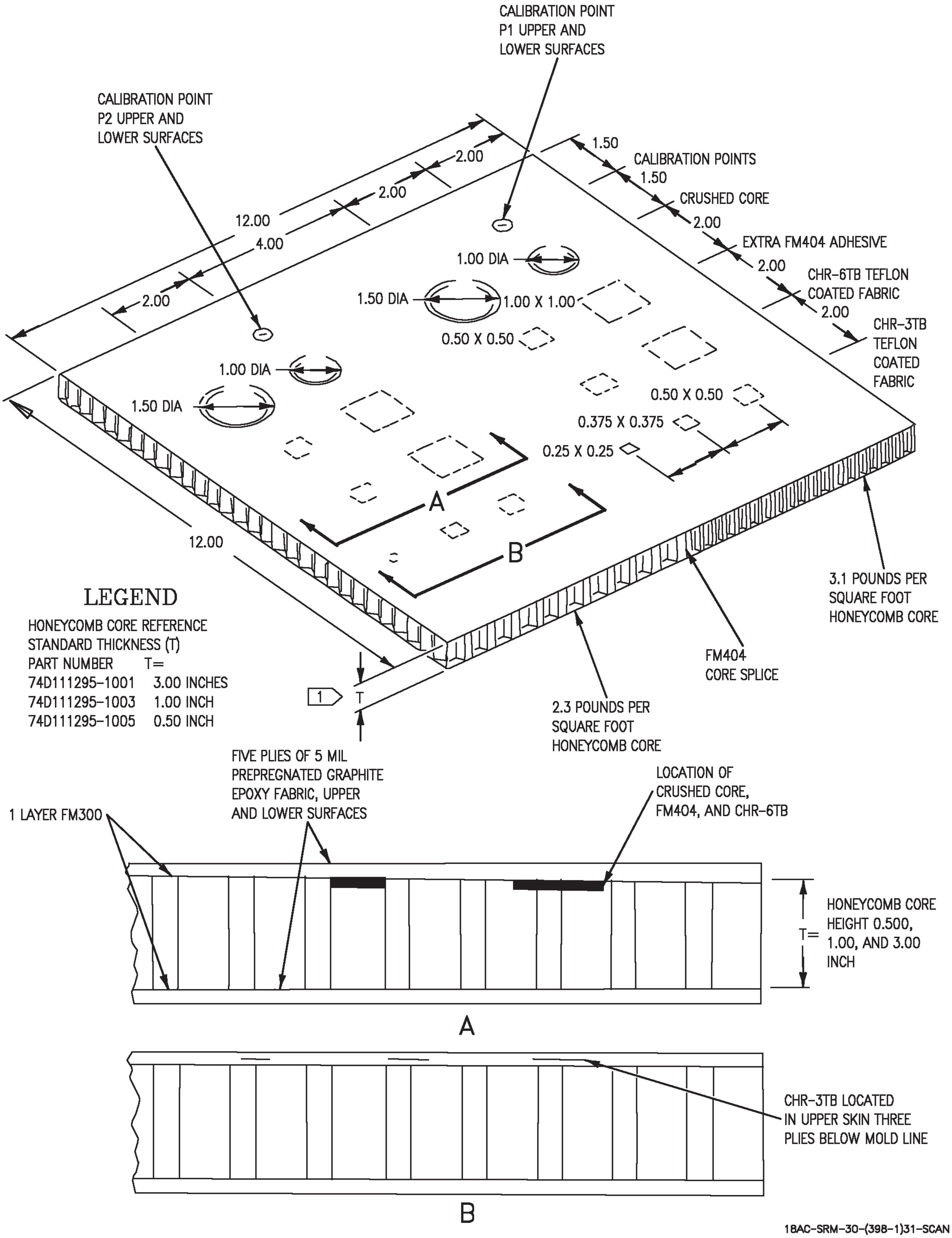


Figure 1. Graphite Epoxy Skinned Honeycomb Core Reference Standard

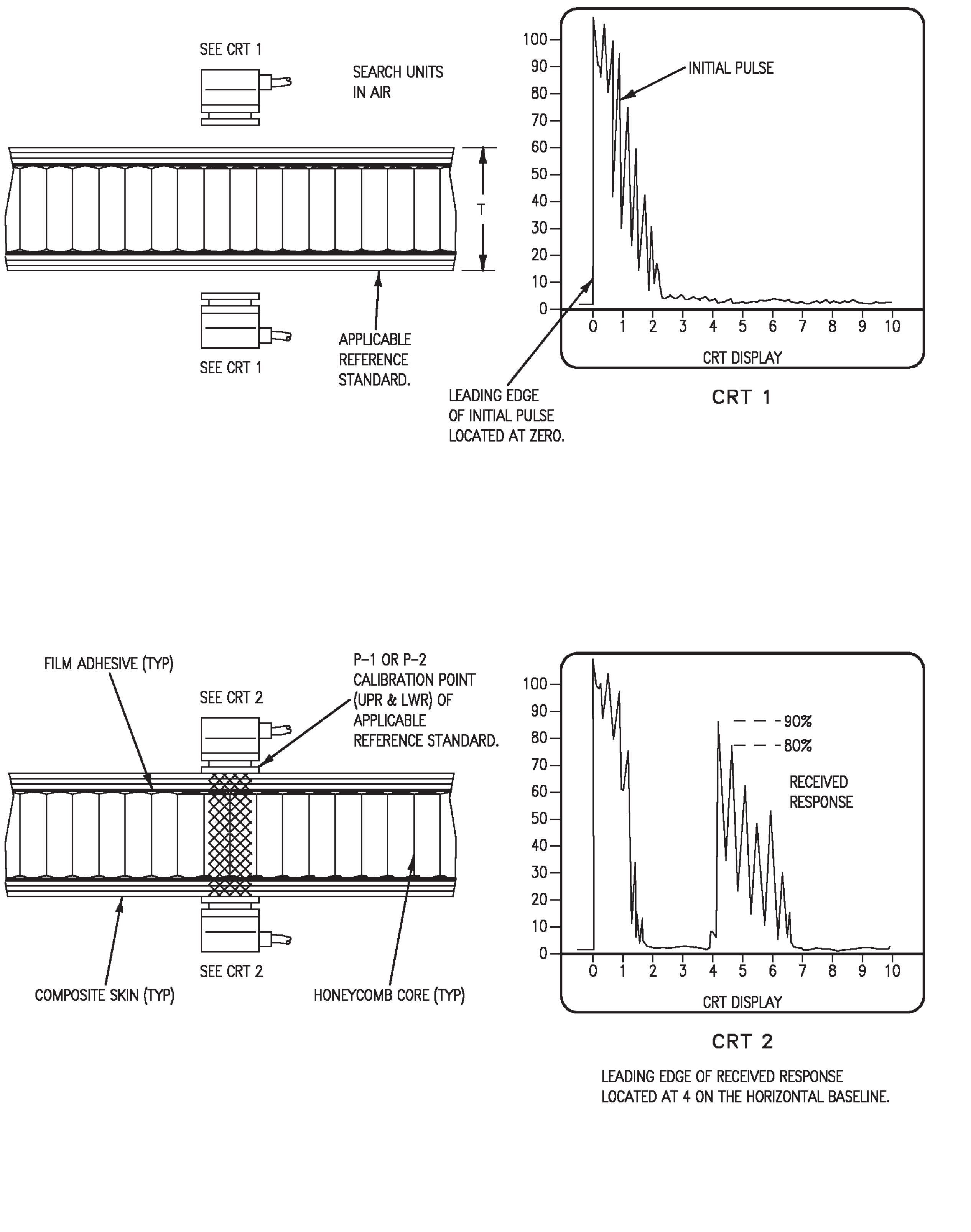
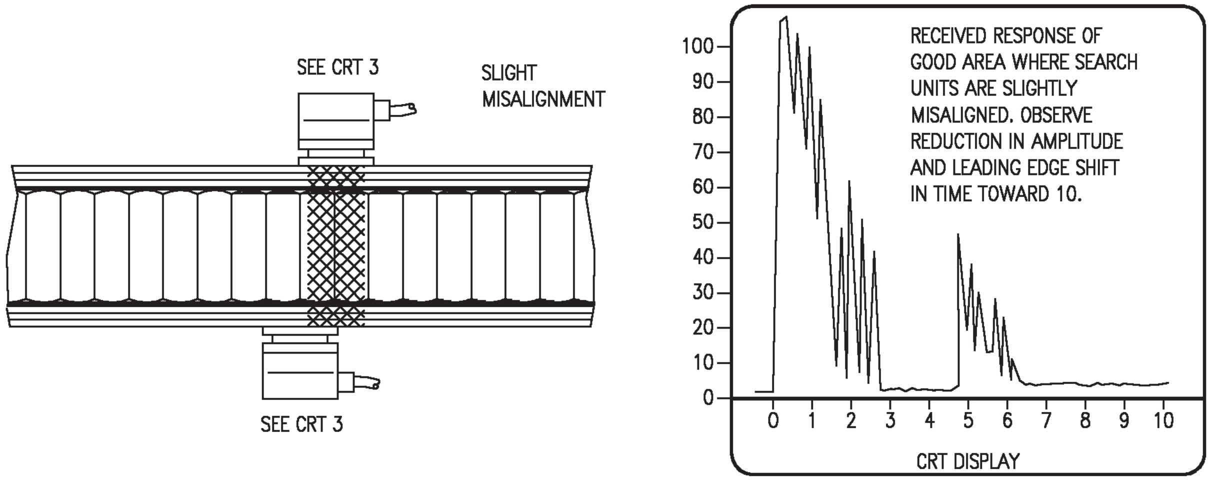
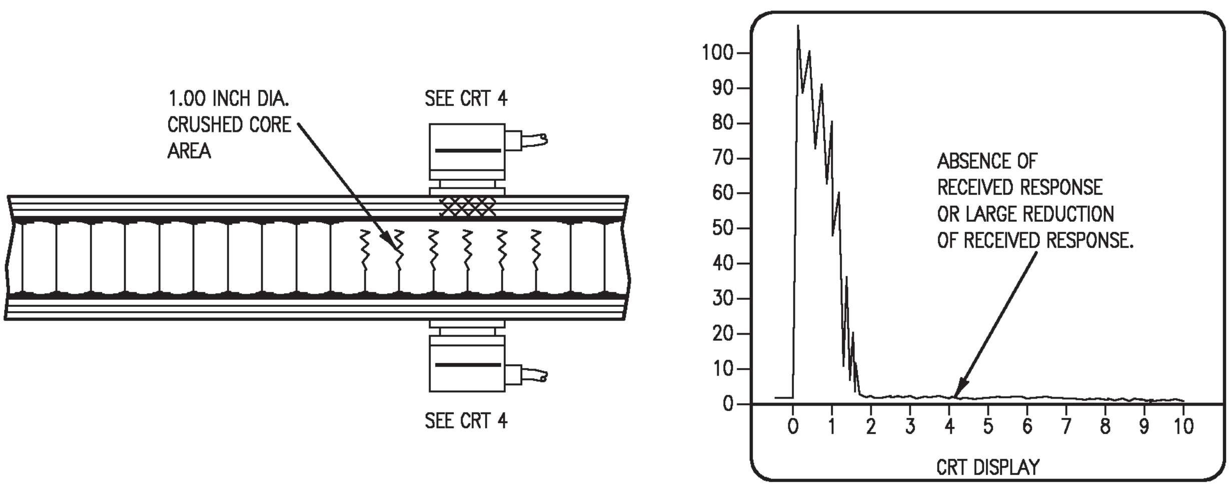


Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 1)



CRT 3



CRT 4

18AC-SRM-30-(399-2)31-SCAN

Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 2)

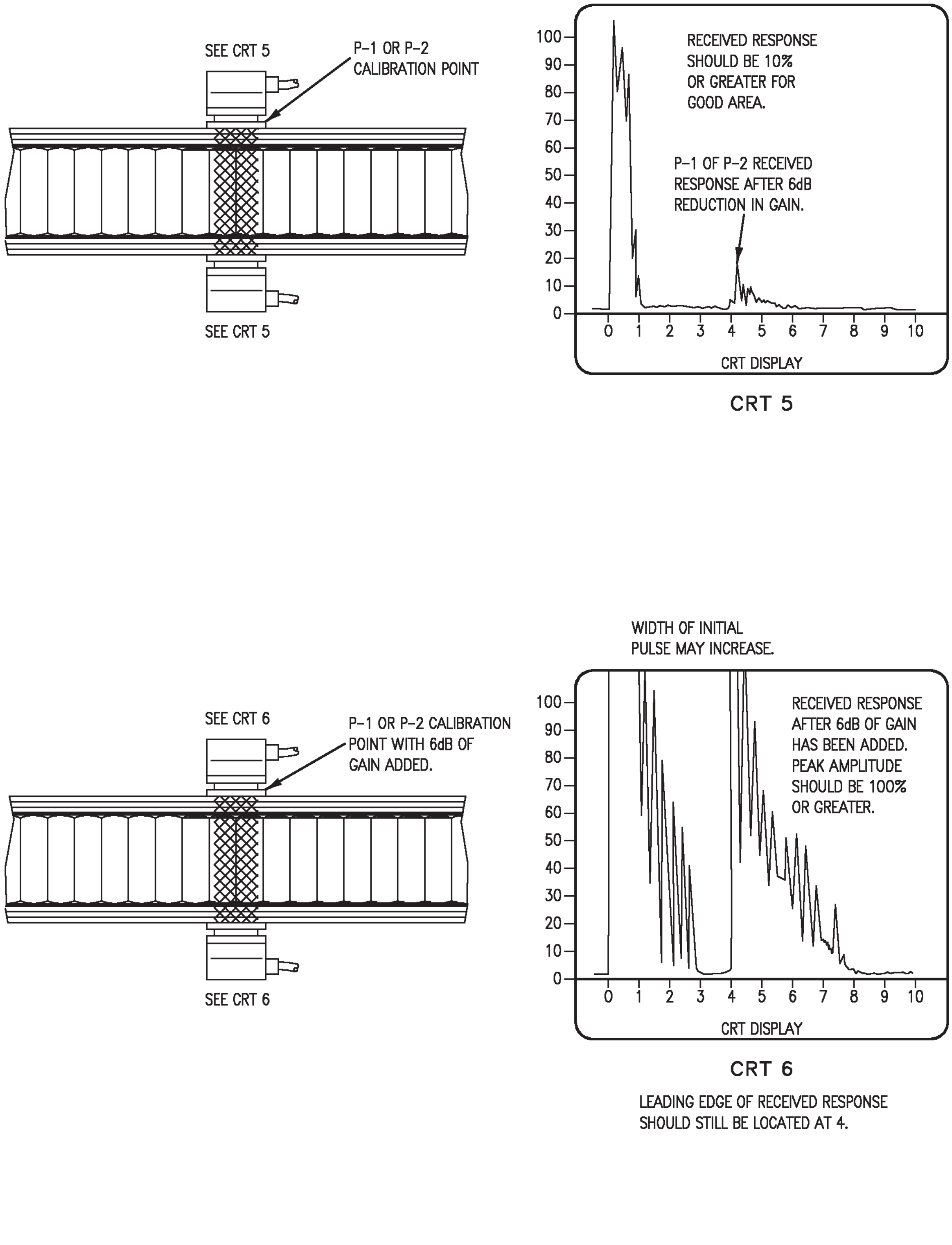
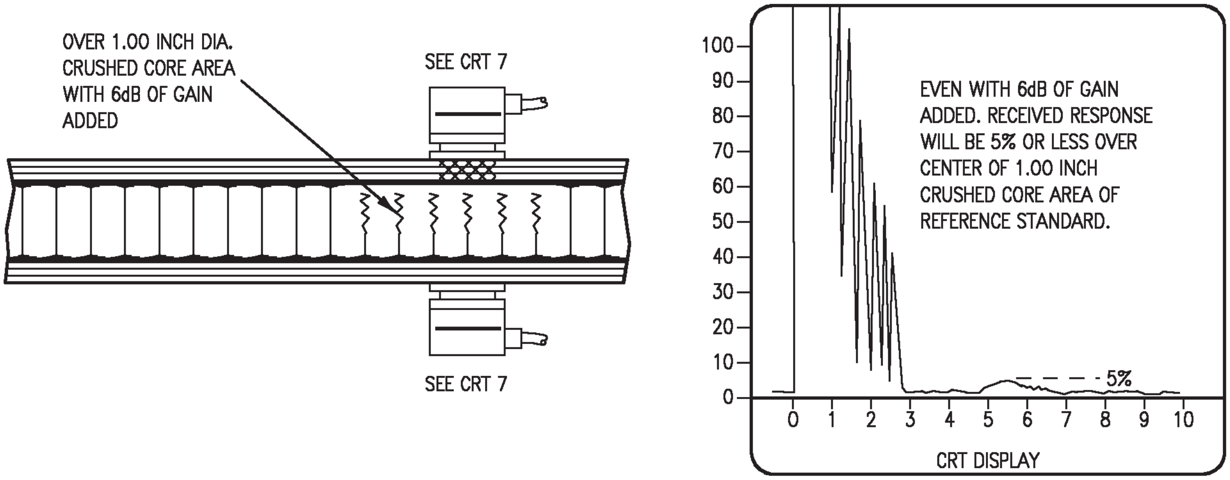
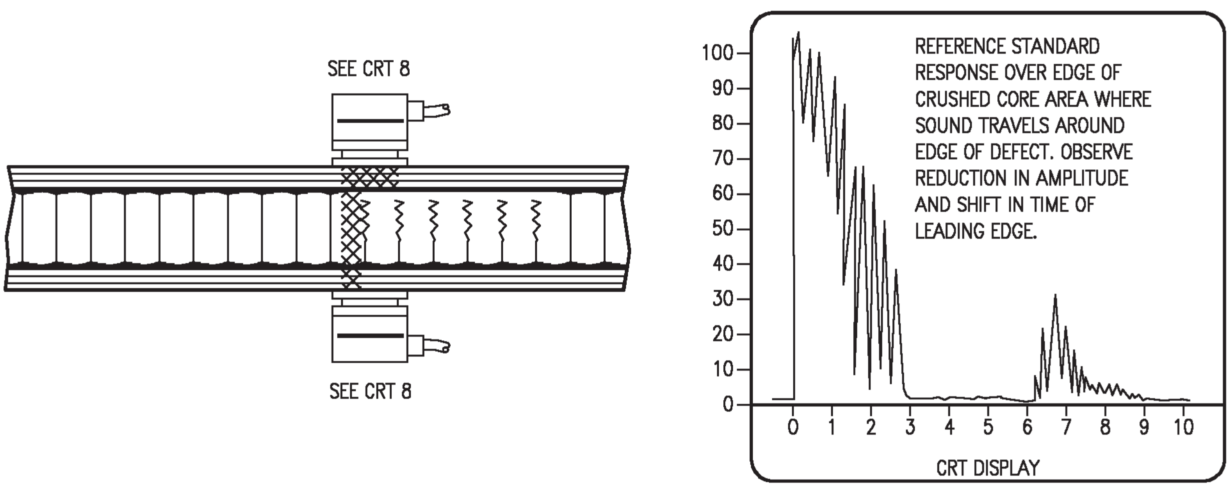


Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 3)



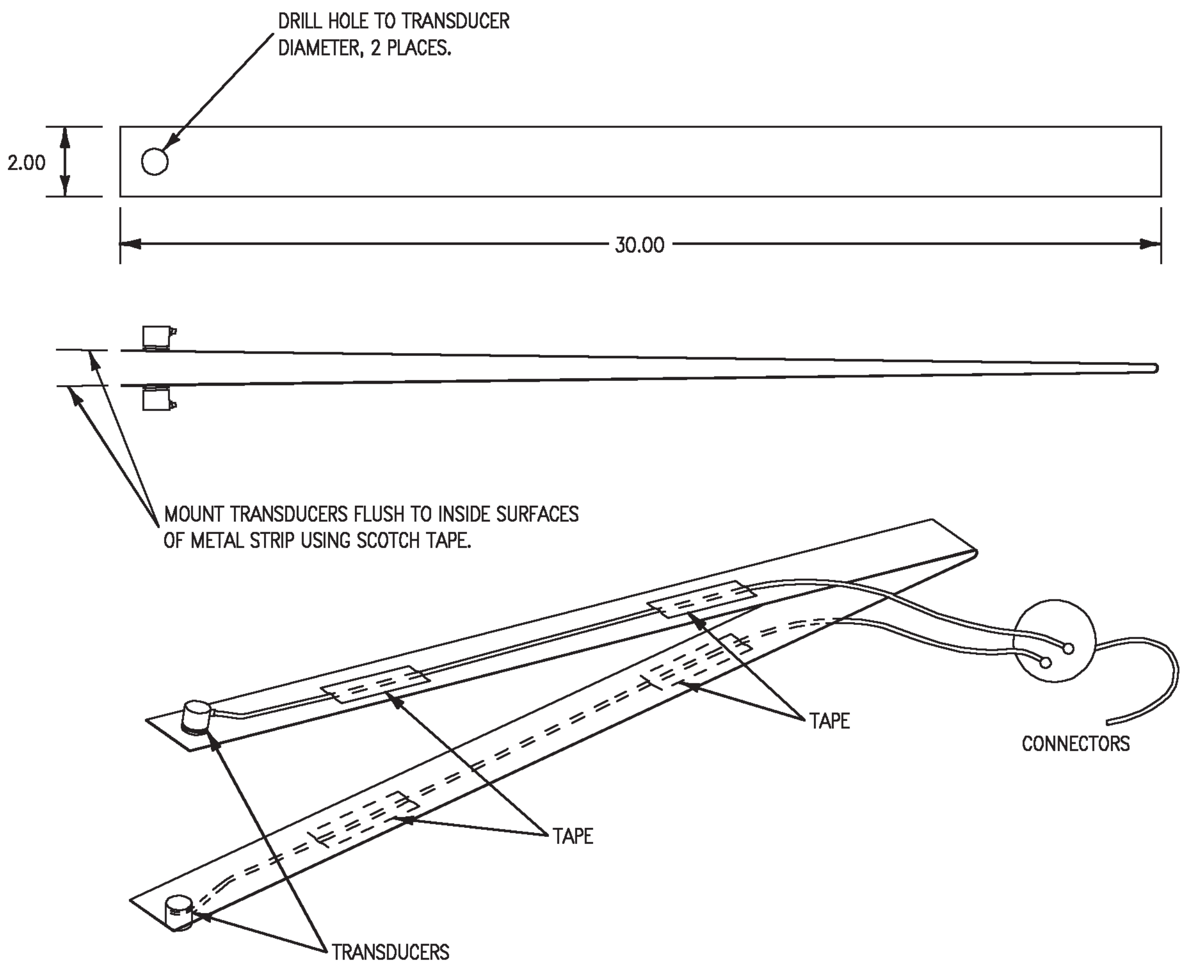
CRT 7



CRT 8

18AC-SRM-30-(399-4)31-SCAN

Figure 2. Setup for Inspection of Honeycomb Core Sandwich Assemblies (Sheet 4)

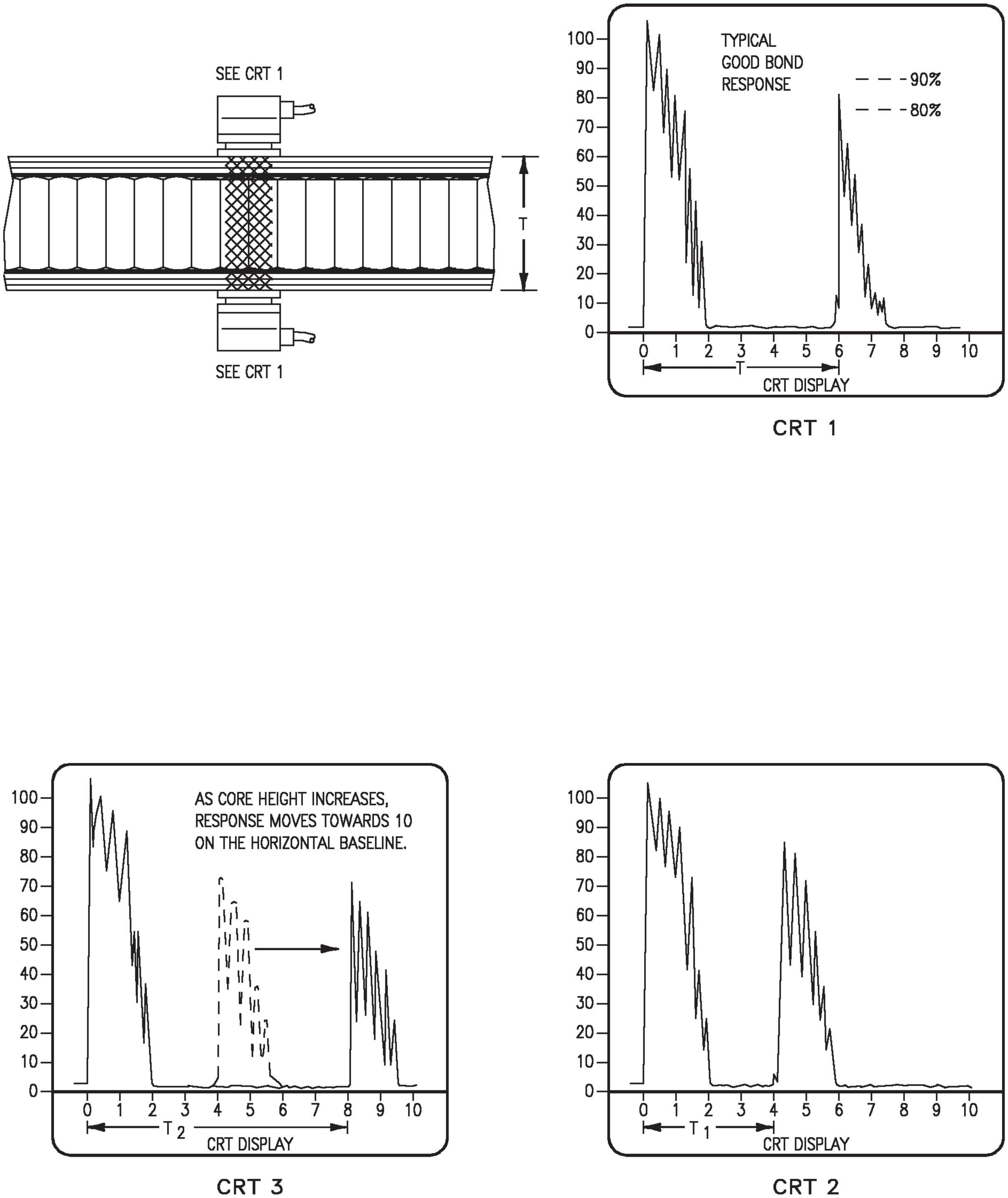


LEGEND

1. ANY 1/32-INCH OR LESS ALUMINUM MATERIAL.
2. HAND FORMED BEND RADIUS OF 1/4-INCH, APPROX.
3. THIS IS A HAND FORMED ALIGNMENT DEVICE USED ONLY TO COAXIALLY ALIGN TRANSDUCERS, SEARCH UNITS.

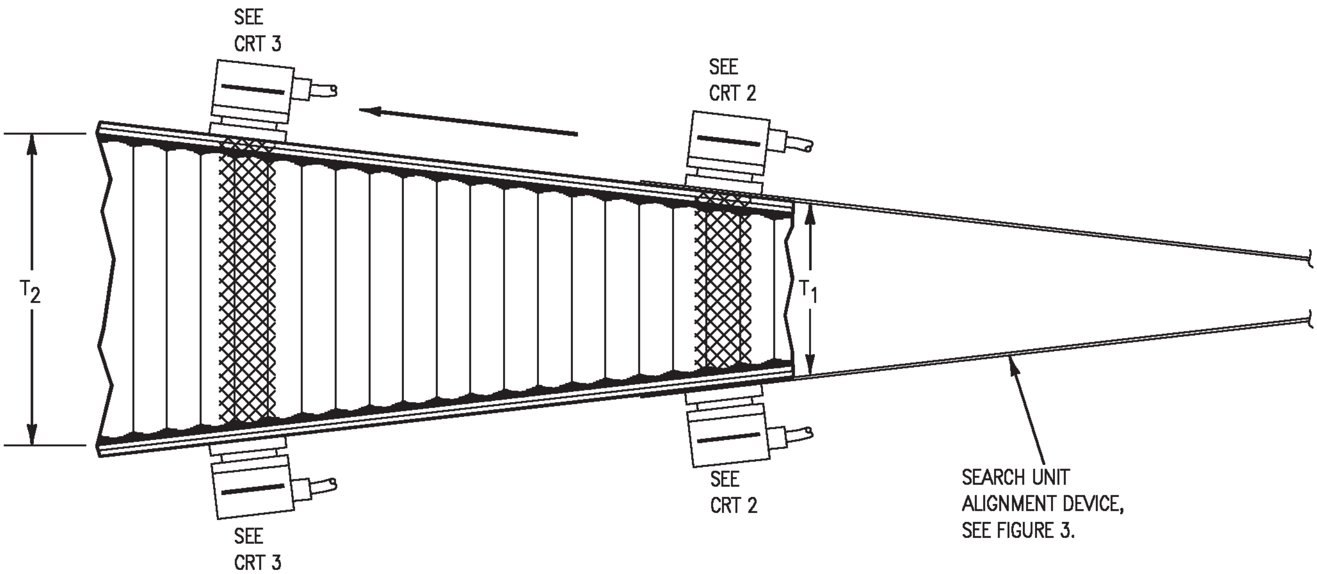
18AC-SRM-30-(400-1)31-CATI

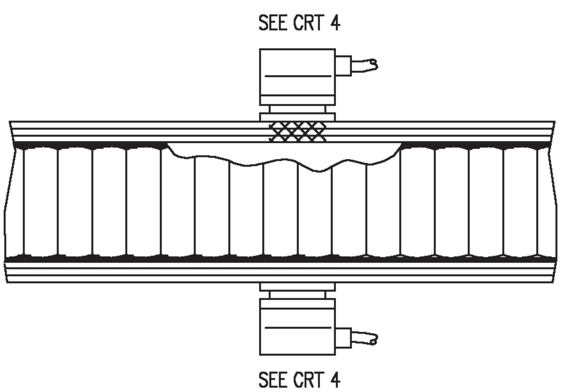
Figure 3.Typical Search Unit Alignment Device

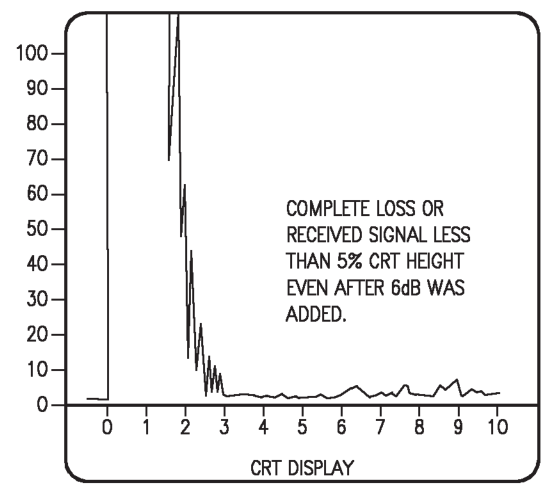


18AC-SRM-30-(401-1)31-SCAN

Figure 4. Typical Inspection Responses on Honeycomb Core Sandwich Assemblies (Sheet 1)



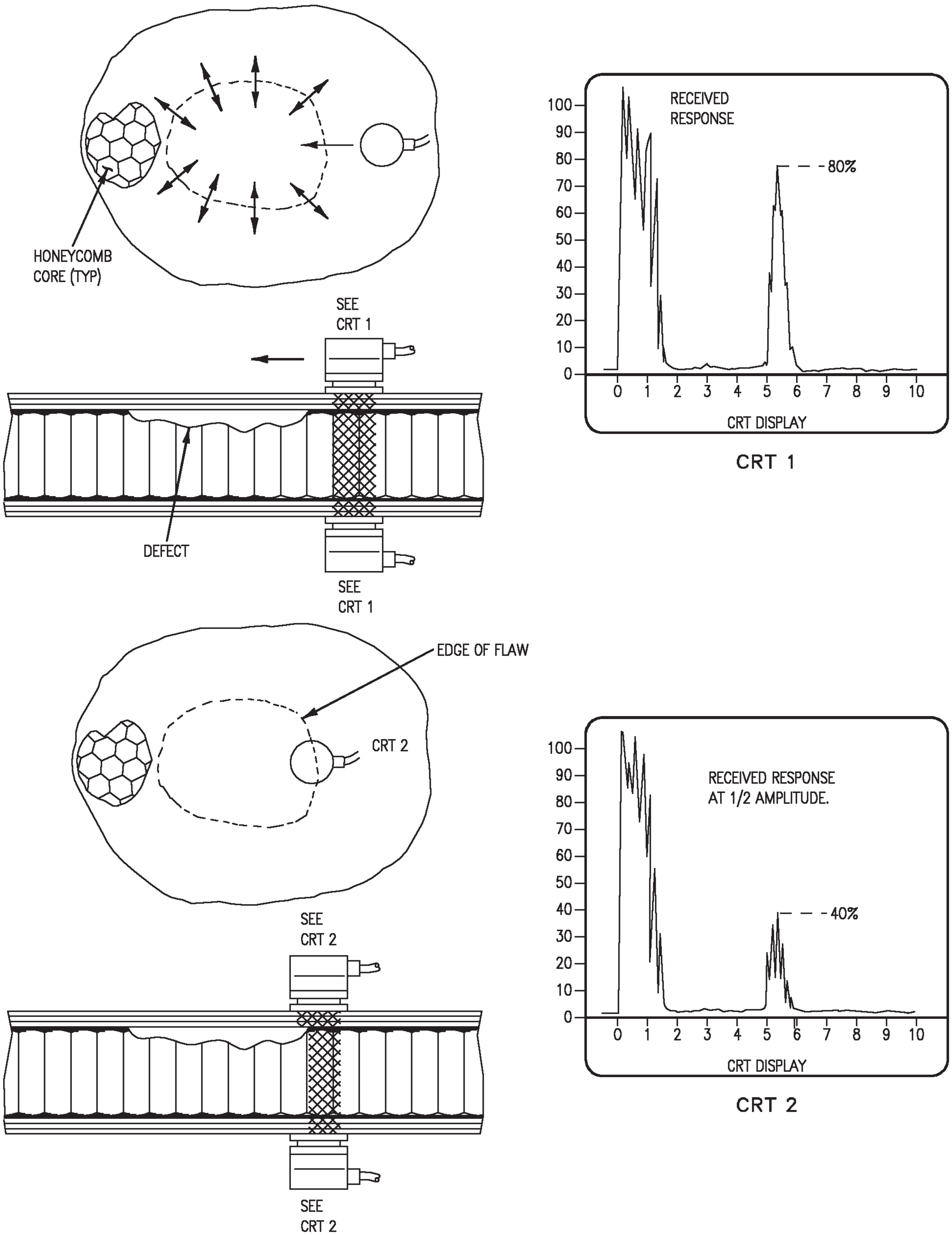




CRT 4

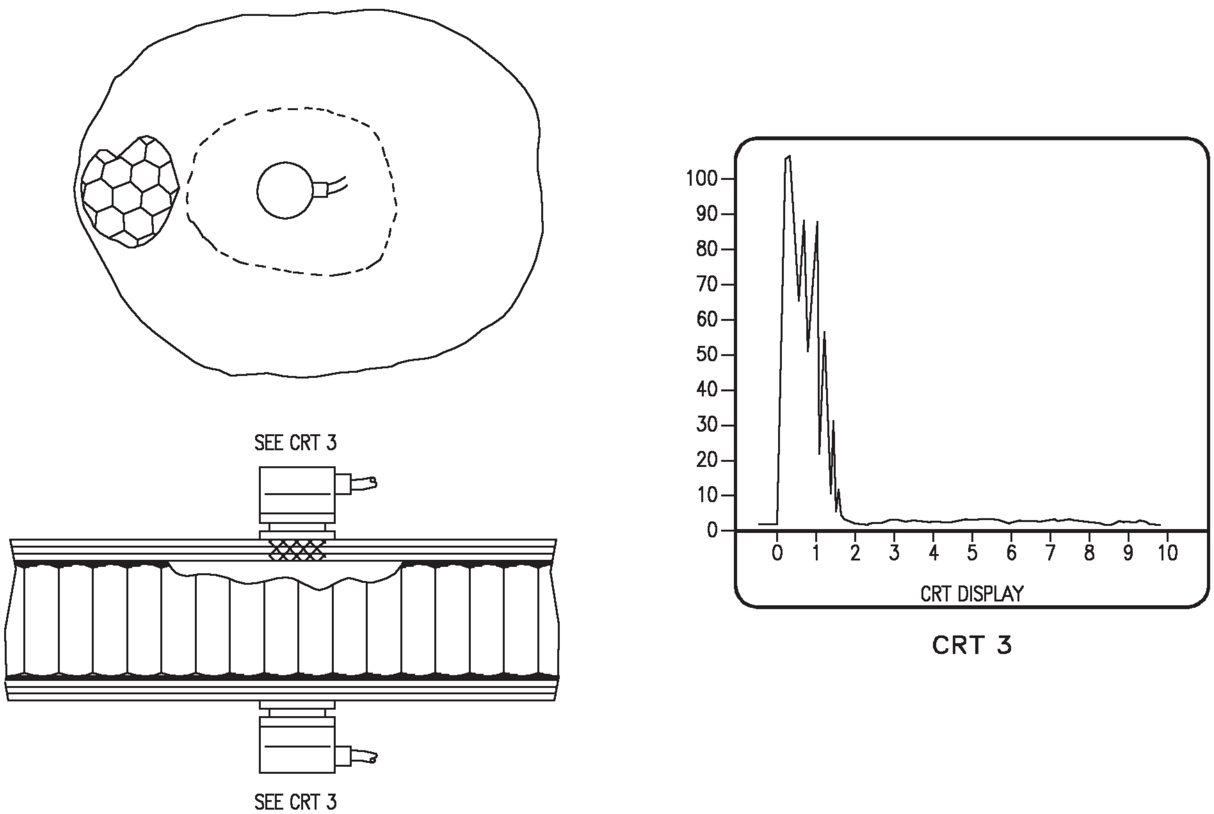
18AC-SRM-30-(401-2)31-SCAN

Figure 4. Typical Inspection Responses on Honeycomb Core Sandwich Assemblies (Sheet 2)



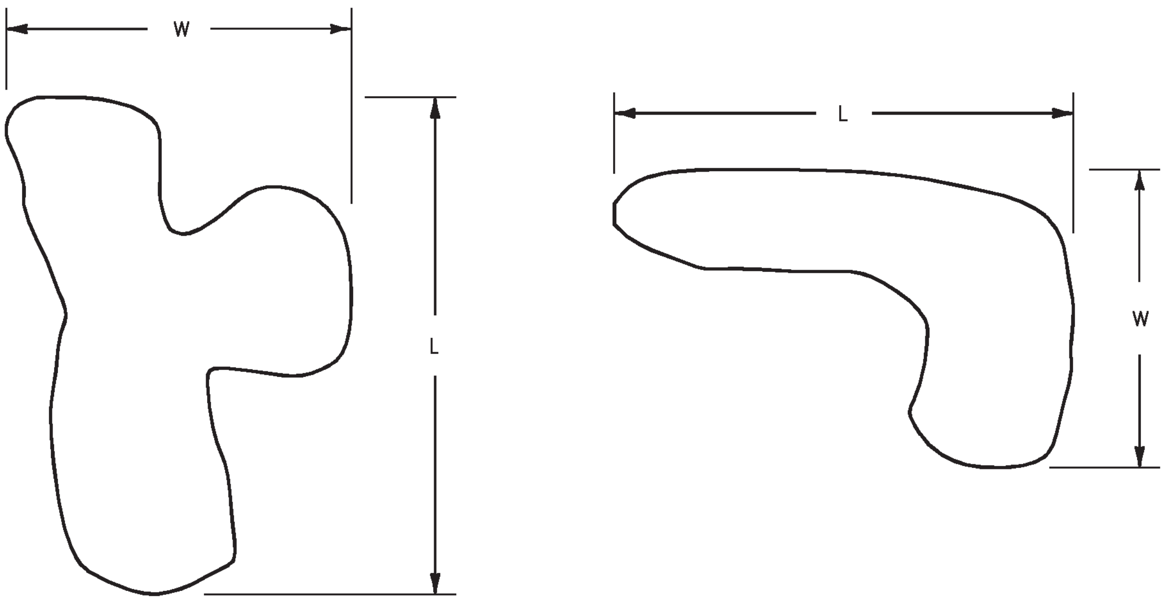
18AC-SRM-30-(402-1)31-SCAN

Figure 5. Half Amplitude Mapping (Sheet 1)



18AC-SRM-30-(402-2)31-SCAN

Figure 5. Half Amplitude Mapping (Sheet 2)



UNBOND
CURVE

L=LENGTH

W=WIDTH

18AC-SRM-30-(402-3)31-CATI

Figure 5. Half Amplitude Mapping (Sheet 3)

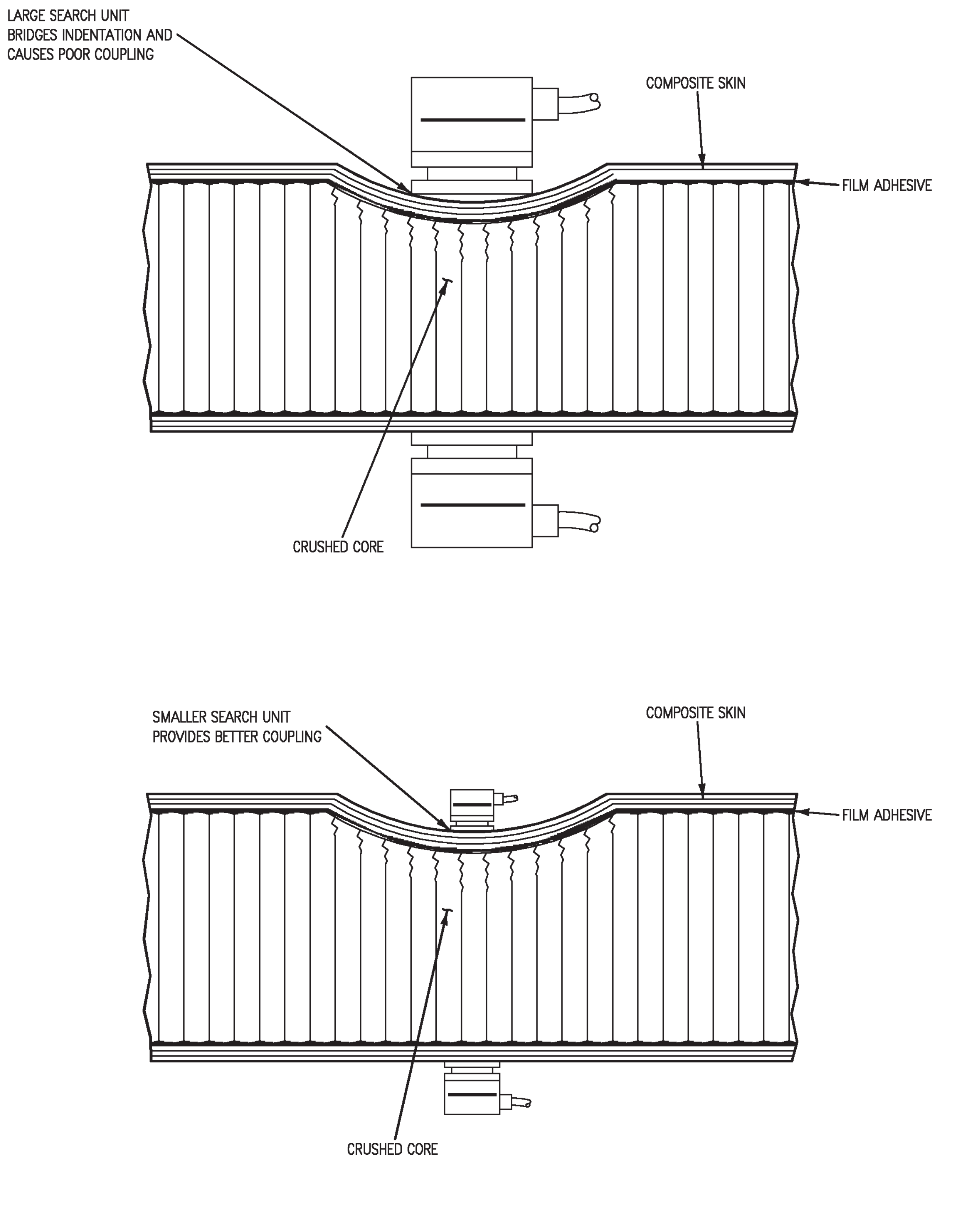


Figure 6. Typical Inspection on Honeycomb Core Sandwich Assemblies

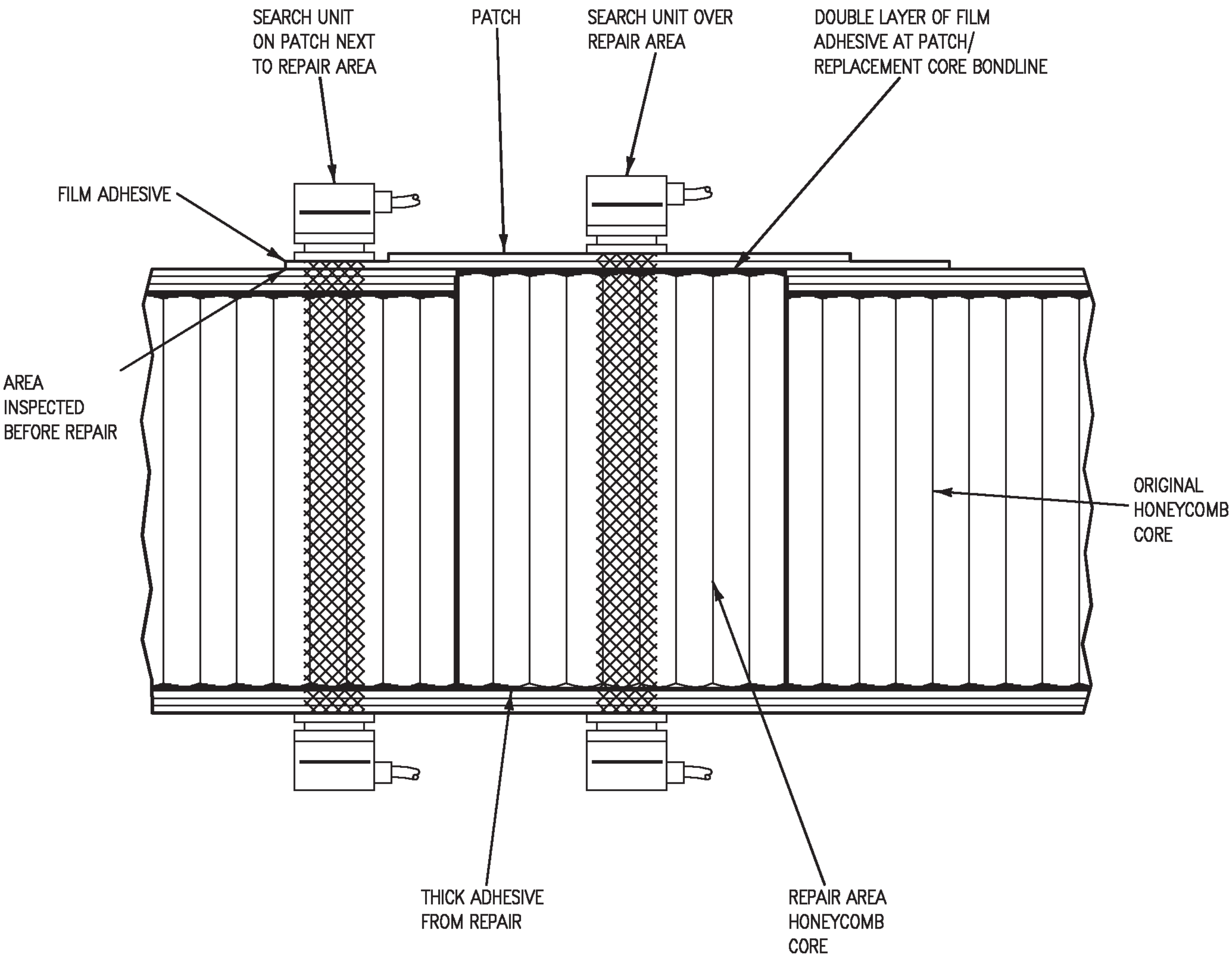
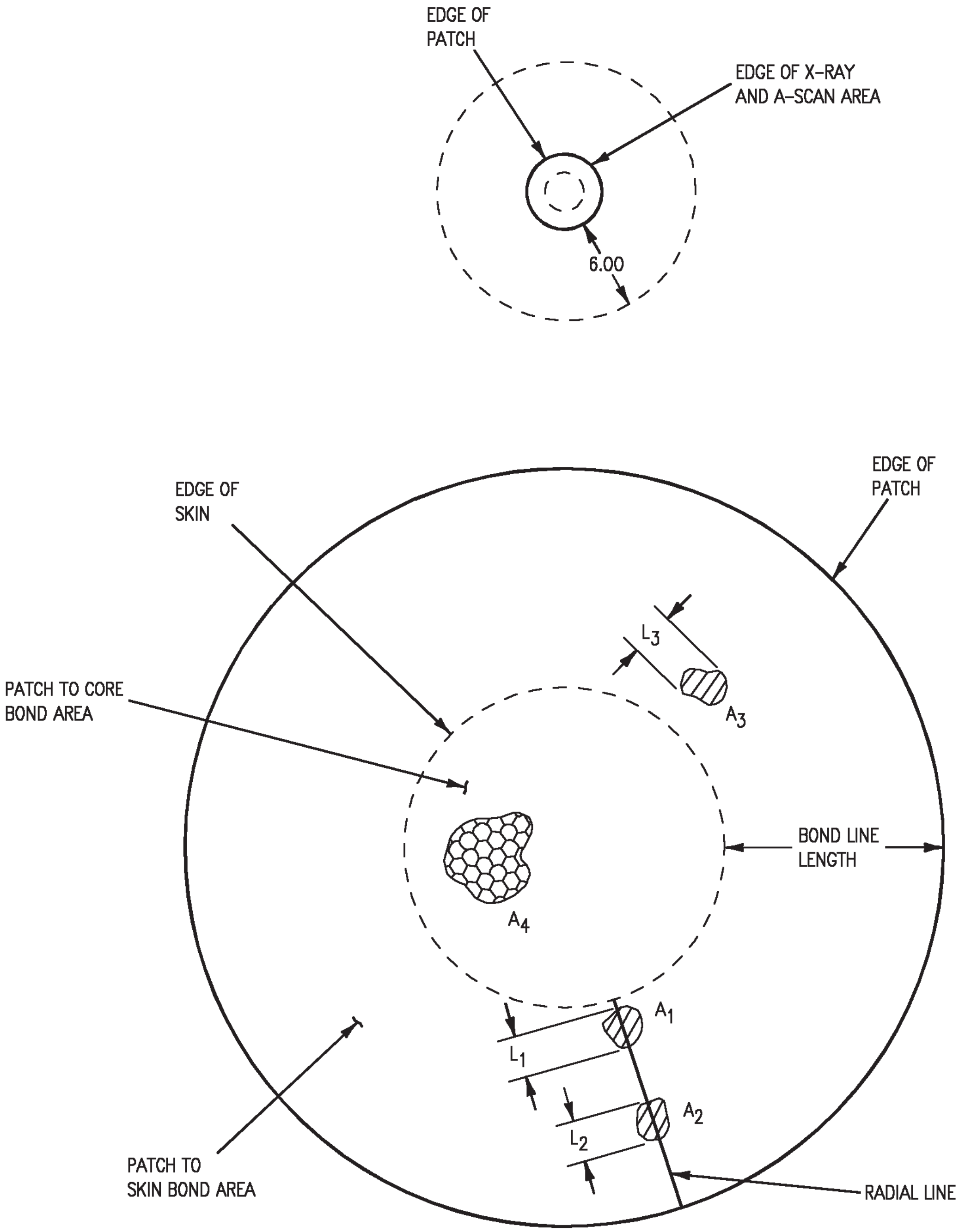


Figure 7. Setup for Typical Repair Evaluation



LEGEND

1. L = LENGTH
2. A = AREA
3. ACCEPTABLE FLAW LIMITS:
   A. $L_1 + L_2$ 0.31 OR LESS AND L_3 0.31 OR LESS
   B. $A_1 + A_2 + A_3$ 20% OR LESS PATCH TO SKIN BOND AREA
   C. A_4 WITHIN SKIN TO CORE UNBOND LIMITS OF SPECIFIC PROCEDURE WORK PACKAGE

18AC-SRM-30-(405-1)31-SCAN

Figure 8. Typical Repair Evaluation

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECH0 LONGITUDINAL, CONTACT, WITHOUT DELAY LINE, FOR COMPOSITE LAMINATE MATERIALS

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000
Nondestructive Inspection A1-F18AC-SRM-300
Pulse-Echo Longitudinal, Contact Thickness Inspection of Metallic Materials and Composite Laminates WP008 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. Pulsed, longitudinal, ultrasonic waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection shall be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI TECHNICIANS, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable, two reqd
57A2214 or EQUIVALENT	0°, 0.25 Dia,5 MHz, Contact Delay Line Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cable.

b. Connect BNC end of connecting cable to T or R BNC jacks on ultrasonic flaw detector (tester).

c. Turn tester ON, allow 5 minutes warm-up.

d. Set tester front face settings;

NOTE

Tester settings listed here are given as initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.

HORIZONTAL
SWEEP DELAY
COURSE 5
FINE 9.0
HORIZONTAL
SWEEP LENGTH
COURSE 1
FINE 7.0
POLARITY .... OFF
DISTANCE ECHO
CORRECTION .... OFF

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water or cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

f. With search units held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

6. **TIME-BASE STANDARDIZATION.**

7. **Composite Laminates Up to 0.450 Inch Thick.** This time base standardization is required because delaminations in composite materials are detected ultrasonically as changes in material thickness. For composite materials up to 0.450 inch thick, use 74D111295-1009 FBH reference standard, which is part of the 74D110175-1001 reference standard set, to complete following time base standardization sequence. This sequence of steps will set tester so one large division on horizontal baseline of the CRT will represent 0.050 inch of material. Depth of unknown responses can be calculated after this standardization is complete.

Unknown Response Depth (Thickness) = CRT Large Division X 0.050 inch per CRT Large Division

NOTE

Flat bottom holes are machined into FBH reference standards to create known depths or thicknesses of material. Number listed before abbreviation, FBH, in text that follows, represents material thickness or depth of material above ultrasonic reflecting surface of flat bottom hole. Thicknesses may vary from standard to standard. Reference standard used should be of same materials as part(s) being inspected.

a. Begin with front face settings as described in paragraph 5.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to upper surface of composite laminate FBH reference standard, over 0.400 see figure 1, FBH.

c. Position search unit over 0.400 FBH.

d. Adjust HORIZONTAL SWEEP DELAY and LENGTH until back surface response from 0.400 FBH is visible on CRT.

e. Adjust GAIN so peak amplitude of first back surface response from 0.400 FBH is 80 to 90 percent CRT height. See Figure 2, CRT 1.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. Damp bottom, or reflecting surface, of FBH to make sure correct response if being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Assuming there are no flaws between front surface of reference standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

REJECT greater than 30 percent is not recommended.

g. Use DAMP. and REJECT to optimize response and minimize baseline noise. Remove couplant from reflecting surface of FBH before continuing.

h. With peak amplitude of 0.400 FBH first back surface response at 80 to 90 percent CRT height, adjust HORIZONTAL SWEEP FINE LENGTH to locate leading edge of 0.400 FBH back surface response at 8 on CRT horizontal baseline. See figure 2, CRT 2.

i. Apply couplant to upper surface of composite laminate reference standard above 0.100 FBH.

j. Position search unit over 0.100 FBH.

k. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 2, CRT 3.

l. Damp bottom, or reflecting surface, of FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

m. Remove couplant from reflecting surface before continuing.

NOTE

Make sure trailing edge of initial pulse is located at less than one large division on CRT horizontal baseline when 0.100 FBH first back surface response is 80 to 90 percent CRT height. See figure 2, CRT 4.

n. With peak amplitude of 0.100 FBH first back surface response at 80 to 90 percent CRT height, adjust HORIZONTAL SWEEP FINE DELAY to locate leading edge of 0.100 FBH back surface response at 2 on CRT horizontal baseline. See figure 2, CRT 4.

o. Reposition search unit over 0.400 FBH and verify leading edge of 0.400 FBH back surface response is still located at 8 on horizontal baseline of CRT when peak amplitude of 0.400 FBH response is 80 to 90 percent CRT height. See figure 2, CRT 5, If not, adjust HORIZONTAL SWEEP FINE LENGTH to relocate 0.400 FBH response leading edge to 8.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates up to 0.450 inch in thickness. CRT horizontal baseline is set so each of ten large horizontal baseline divisions represents 0.050 inch of material. See figure 2, CRT 6.

p. If change was required to relocate 0.400 FBH response leading edge to 8 on horizontal baseline of CRT, reposition search unit over 0.100 FBH to verify leading edge of 0.100 FBH response is still located at 2 on CRT horizontal baseline when peak amplitude of 0.100 FBH response is 80 to 90 percent CRT height. See figure 2, CRT 6. Make sure trailing edge of initial pulse is still less than 1, if not, repeat steps n. and o. as many times as required.

q. Test setup by positioning search unit over another FBH, depth of which is accurately known. FBH response leading edge location, when peak amplitude is 80 to 90 percent CRT height, should be as follows:

$$\text{CRT Large Division Response Location} = \frac{\text{FBH Depth (Inch)}}{\text{0.050 Inch per CRT Large Division}}$$

8. **Composite Laminates Up to 0.950 Inch Thick.** Time base standardization is required because delaminations in composite materials are detected ultrasonically as changes in material thickness. For composite materials up to 0.950 inch use 74D111295-1007 FBH reference standard, which is part of 74D110175-1001 reference standard set, to complete following time base standardization sequence. This sequence of steps will set tester such that one large division on horizontal baseline of CRT will represent 0.100 inch of material. Depth of

unknown responses can be calculated after this standardization is complete:

Unknown Response = Depth (Thickness) = CRT Large Division X 0.100 Inch per CRT Large Division

NOTE

For composite laminates up to 0.950 inch, some 5 MHz transducers may be inadequate. A 2.25 MHz transducer may be used if 5 MHz is not enough.

a. Begin with tester front face settings as described in paragraph 5.

b. Change HORIZONTAL SWEEP COURSE LENGTH to 2.0 before beginning.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to upper surface of composite laminate reference standard, over 0.800 FBH. See figure 3.

d. Position search unit over 0.800 FBH.

e. Adjust GAIN, HORIZONTAL SWEEP DELAY and LENGTH until back surface response from 0.800 FBH is visible on CRT.

f. Adjust GAIN so peak amplitude of first back surface response from 0.800 FBH is 80 to 90 percent CRT height. See figure 4, CRT 1.

NOTE

Assuming there are no flaws between front surface of reference standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

g. Damp bottom, or reflecting surface, of 0.800 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

h. Use DAMP. and REJECT to optimize response and minimize baseline noise. Remove couplant from reflecting surface of FBH before continuing.

i. With amplitude of first 0.800 FBH back surface response at 80 to 90 percent CRT height, use HORIZONTAL SWEEP DELAY and LENGTH to locate leading edge of 0.800 FBH at 8 on CRT horizontal baseline. See figure 4, CRT 2.

j. Apply couplant to upper surface of composite laminate reference standard above 0.400 FBH.

k. Position search unit over 0.400 FBH.

l. Adjust GAIN so peak amplitude of first back reflection from 0.400 FBH is 80 to 90 percent CRT height. See figure 4, CRT 3.

m. Damp bottom, or reflecting surface, of FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

n. Remove couplant from reflecting surface before continuing.

o. With peak amplitude of 0.400 FBH first back response at 80 to 90 percent CRT height, use HORIZONTAL SWEEP FINE DELAY locate leading edge of 0.400 FBH back surface response at 4 on CRT horizontal baseline. See figure 4, CRT 4.

p. Reposition search unit over 0.800 FBH and verify leading edge of 0.800 FBH first back surface response is still located at 8 on CRT horizontal baseline. See figure 4, CRT 5. If not, use HORIZONTAL SWEEP FINE LENGTH to relocate 0.800 FBH response leading edge to 8.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates up to 0.950 inch in thickness. CRT horizontal baseline is set so each of 10 large horizontal baseline divisions represents 0.100 inch of material. See figure 4, CRT 6.

q. If changes were required to relocate 0.800 FBH response leading edge to 8 on CRT horizontal

baseline, reposition search unit over 0.400 FBH to verify leading edge of 0.100 FBH response is still located at 4 on CRT horizontal baseline. If not, repeat steps o. and q. as many times as required.

r. Test setup by positioning search unit over another FBH, depth of which is accurately known. FBH response leading edge, when peak amplitudes is 80 to 90 percent CRT height, should be as follows:

$$\text{CRT Large Division Response Location} = \frac{\text{FBH Depth (Inch)}}{\text{0.100 Inch per CRT Large Division}}$$

NOTE

Before beginning inspection, use 74D111295-1009 FBH reference standard to make sure trailing edge of initial pulse is located at less than one large division on CRT horizontal baseline when 0.100 FBH first back surface response is 80 to 90 percent CRT height.

9. INSPECTION PROCEDURES.

10. Inspection of Solid Laminates.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Before beginning inspection, determine locations of ply changes, rabbets, stiffeners, and other items lying beneath surface of area to be inspected. This information should be described in specific procedure work packages. Lay out locations of ply changes, rabbets, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar overlay. Also include applicable thicknesses of part or areas of part on overlay.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

c. To make sure large parts are completely inspected, mark grid pattern on inspection area per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5 and 6 for composite thickness of part being inspected.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit wear face should be parallel to back surface of laminate. See figure 5, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 5, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 of search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 7. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at an angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at rate no greater than 1 to 2

feet per minute. Scan entire area within one grid block before inspecting next grid block.

i. Use guidelines given in paragraph 12 on CRT interpretation to identify flaws.

j. Once flaw has been identified, use pulse-echo mapping technique shown in figure 8 and described in paragraph 23.a. for 1/2 amplitude mapping, and figure 9, paragraph 23. b. for mapping flaws close to surface or small multiple delaminations to

determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge or by using delay line technique when defect is closer to surface.

k. Mark flaw indications on part surface with aircraft marking pencil.

11. **Edge Repair Inspection.**

a. Determine laminate thickness in repaired area and area to repair.

b. Mark original damage outline on part surface with aircraft marking pencil as shown in figure 6.

c. Standardize tester per paragraph 5 and 6 for composite thickness range used in evaluating original damage.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

d. Apply couplant to repaired area and surrounding good area, usually 1 inch beyond original flaw outline.

e. Position search unit on nearby non flawed area. Adjust GAIN to locate back surface at 80 to 90 percent CRT height. See figure 6, CRT 1. If possible, finger damp back surface to make sure correct response is being received and viewed on CRT.

f. Move search unit from nearby non-flaw area to repaired area, monitoring back surface response leading edge location on horizontal baseline and back surface response peak amplitude. Refer to paragraph 18 for CRT interpretation/flaw identification guidelines.

g. Mark all areas with aircraft marking pencil, where back surface response disappears.

h. After marking preliminary flaw outline, use applicable amplitude mapping technique shown in figures 11 and 12 and described in paragraphs 23.a. and 23.b. to determine edge of remaining defect.

i. Mark all flaw indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

12. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, back surface response, and possibly back surface response multiples should be visible on CRT. Back surface response should be located at CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 5, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed before inspection, described in paragraph 6.

13. **Single Level Delamination .** A delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 5, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 5, CRT 3.

14. **Small Delaminations/Porosity and Large Near Surface Delaminations.** Small delamination/porosity throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 5, CRT 4.

NOTE

If not clear whether indication is due to near surface delamination or presence of heavy porosity, and back surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates delamination is present. If small response is detected, it is likely area contains heavy porosity.

15. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate response may be due to presence of numerous planar voids and multiples from single planar voids. See figure 5, CRT 5.

16. **Multiple Level Delaminations.** Appearance of more than one intermediate response and absence of back surface response may indicate multiple level delamination. Example is shown in figure 5, CRT 6. Depending on depth of each delamination level, multiples from various levels may also appear. See figure 5, CRT 7.

NOTE

Too much gain may result in sensitivity level where meaningless responses will appear. Increasing gain may produce intermediate response multiples.

17. **Tapers.** Tapers should be described in specific work package or in specific structure repair work packages (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area. When search unit is placed over area outside of taper, where front and back surfaces of part are parallel, back surface response will appear at CRT horizontal baseline corresponding to part thickness at that point. GAIN should be adjusted to back surface response at such point is 80 to 90 percent CRT height. See figure 5, CRT 8. As search unit is moved across area of taper in which thickness of part is increasing, back surface response will decrease in amplitude and move away from initial pulse. See figure 5, CRT 9. As search unit is moved across area of taper in which thickness of part is decreasing, back surfaces response will increase in amplitude and move toward initial pulse. If back surface amplitude is significantly decreased due to added thickness on taper, increase gain so back surface response is back up to 80 to 90 percent CRT height. See figure 5, CRT 10. Depending on new part thickness when taper ends, gain may need to be adjusted again so back surface response is 80 to 90 percent CRT height. See figure 5, CRT 11. Intermediate responses may appear when gain is increased.

18. **Edge Repair.** Adhesive filled edge repair area will result in intermediate response from repair area and reduction in back surface amplitude due to attenuation from repair area. See figure 5, CRT 12. Repair area containing adhesive void will be indicated by intermediate response and absence of back surface response. Increase in amplitude of intermediate response compared flaw free repair area response is likely, but may not always occur. See figure 5, CRT 13.

NOTE

When inspecting areas containing liquid shim, it may be required to increase gain to peak back surface response. Intermediate responses may occur when gain is increased.

19. **Liquid Shim.** When search unit is placed over laminate containing liquid shim between skin and substructure, several responses are possible. When search unit is placed over sealant groove, back surface amplitude may be reduced since energy is coupled into liquid shim and channel sealant. See figure 5, CRT 14. In other areas, where there is liquid shim between laminate and substructure, back surface response may be decreased in amplitude, since some energy is coupled into shim and substructure. Reflections from shim/substructure and substructure/air interfaces may appear. See figure 5, CRT 15. Rather than appearing as distinct responses to left of back surface response, back surface response will be broadened and decreased in amplitude due to reflections from shim/substructure and substructure interfaces.

20. **Abrupt Thickness Change.** Locations of abrupt thickness changes should be noted in specific work packages or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750). When search unit is placed over area containing thickness change, back surface response from each thickness will appear. Amplitude of each response will be reduced compared to signal from single thickness area. See figure 5, CRT 16.

21. **Cocured Composite Stiffener.** As search unit is moved across area containing cocured composite stiffener, variety of responses will occur. Example is shown in figure 5, CRTs 17 through 20 before search unit is placed over underlying stiffener, there should be back surface response, its amplitude between 80 and 90 percent height located at CRT horizontal baseline representing its thickness, T1. See figure 5, CRT 17. Moving search unit across laminate surface so it covers part of underlying composite flange, back surface response will decrease in amplitude as flange response appears. With half of search unit covering flange, both back surface and flange responses will have decreased amplitudes compared to original back surface

response. Flange response will be located at CRT horizontal baseline location representing T2, sum of laminate and flange thicknesses. See figure 5, CRT 18. Depending on laminate and flange thicknesses, as well as tester settings, laminate and flange responses may not be distinct so only one broadened response with reduced amplitude appears. When search unit is moved completely over flange, back surface response may completely disappear so only flange response appears. Flange response should have increased amplitude compared to responses when half of search unit covered flange, and should be located at CRT horizontal baseline division representing T2. See figure 5, CRT 19. Depending on thicknesses and flaw detector settings, small back surface response may still be received. When search unit is placed directly over stiffener, response may completely disappear since ultrasonic energy is coupled into stiffener. See figure 5, CRT 20. If stiffener is unbonded from laminate back surface or if there are voids, back surface response will appear and will be located at CRT horizontal baseline division representing T1, laminate thickness. Amplitude of this response will depend on size of unbond, void, etc. at interface since defect size will determine amount of ultrasonic energy coupled into stiffener. Even if there are no defects at stiffener/back surface interface, small back surface response may be present at T1 location on CRT horizontal baseline.

22. **Excess Resin.** Responses may result from excess resin, or resin-rich areas, in laminates. Excess resin will cause an intermediate response, combined with slight reduction in back surface response. See figure 5, CRT 21.

23. **MAPPING.**

a. Half amplitude Mapping.

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 8, CRT 1.

(3) Move search unit toward good areas in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude. See figure 8, CRTs 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping for Flaws Close to Surface or Small Multiple Delaminations.

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 9, CRT 1.

(3) Move search unit in toward flaw in all directions. Use Aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent of CRT height. See figure 9, CRTs 2 and 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 10.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

24. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for the inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part.

c. Determine depth of defects, when required by using equations in paragraph 7. and 8. If more accurate measurements are required do depth measurement using thickness gauge in (WP008 08).

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

25. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to air dry for 15 minutes after cleaning.

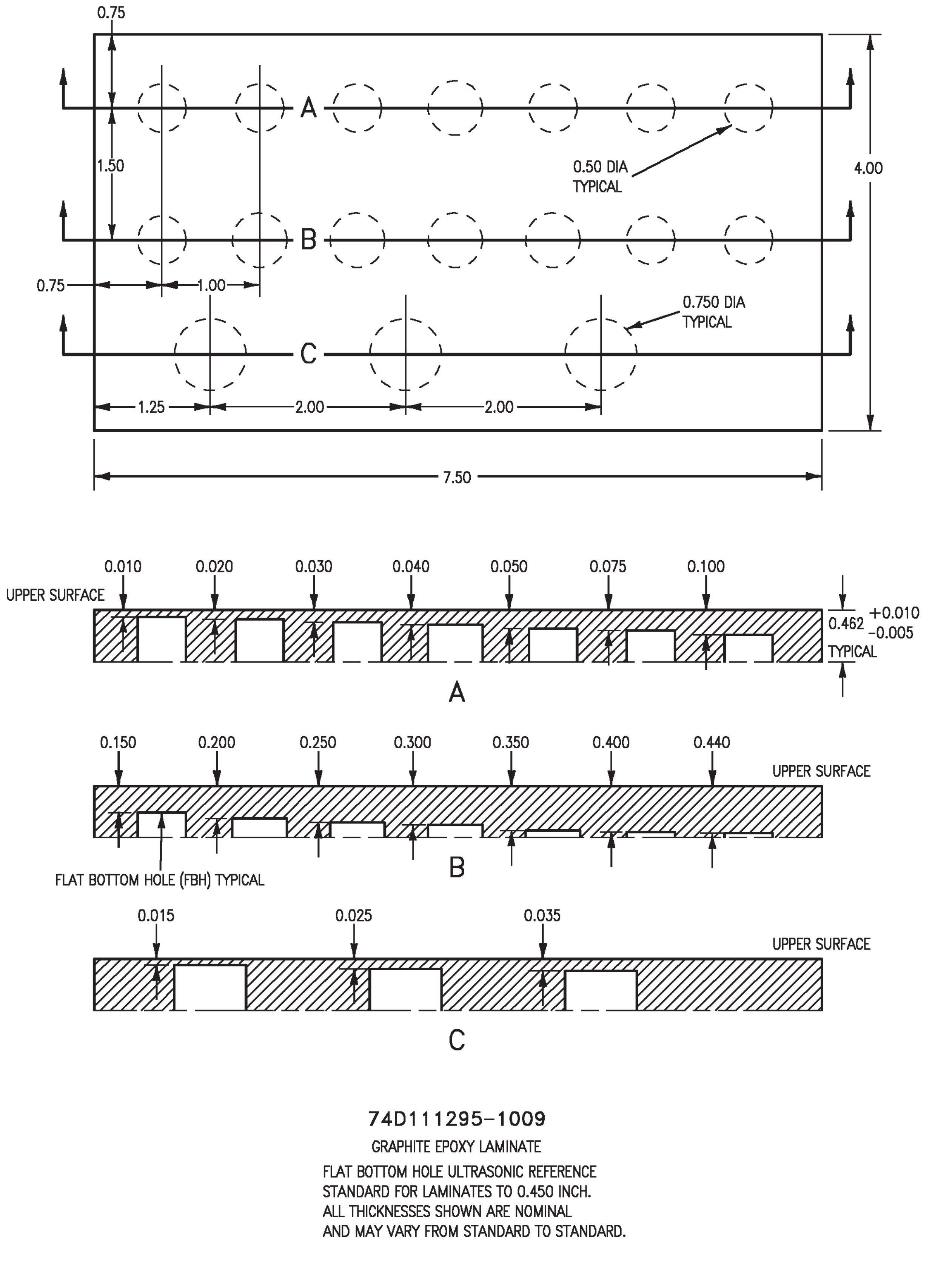
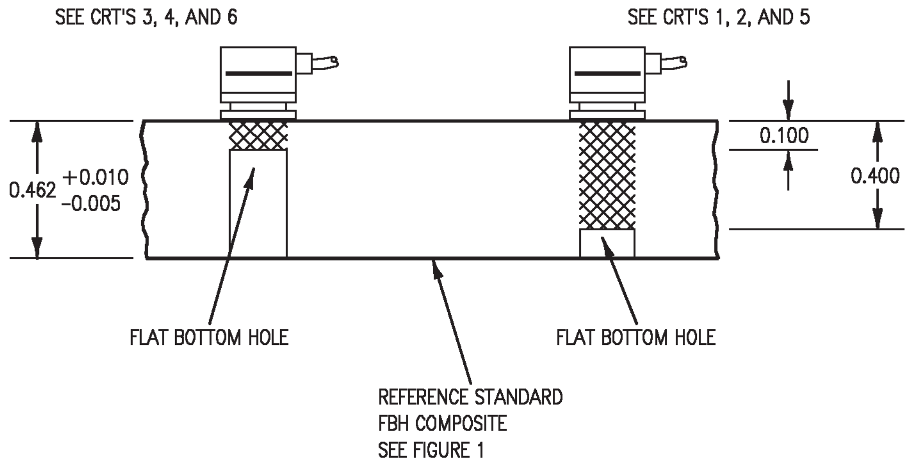
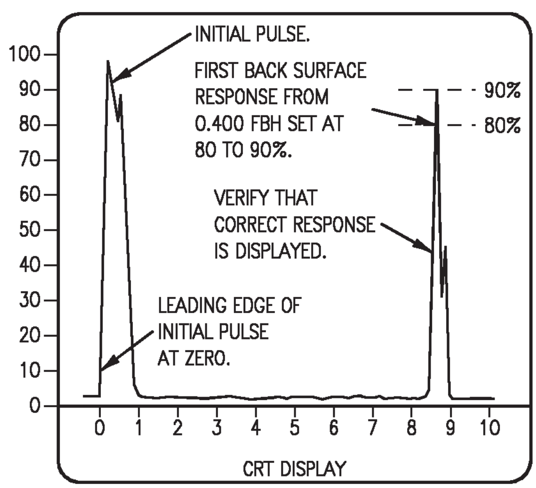
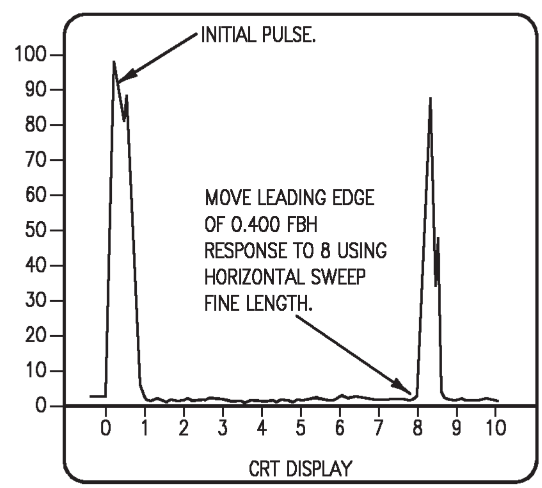


Figure 1. FBH Reference Standard For 0.450 Inch Setup





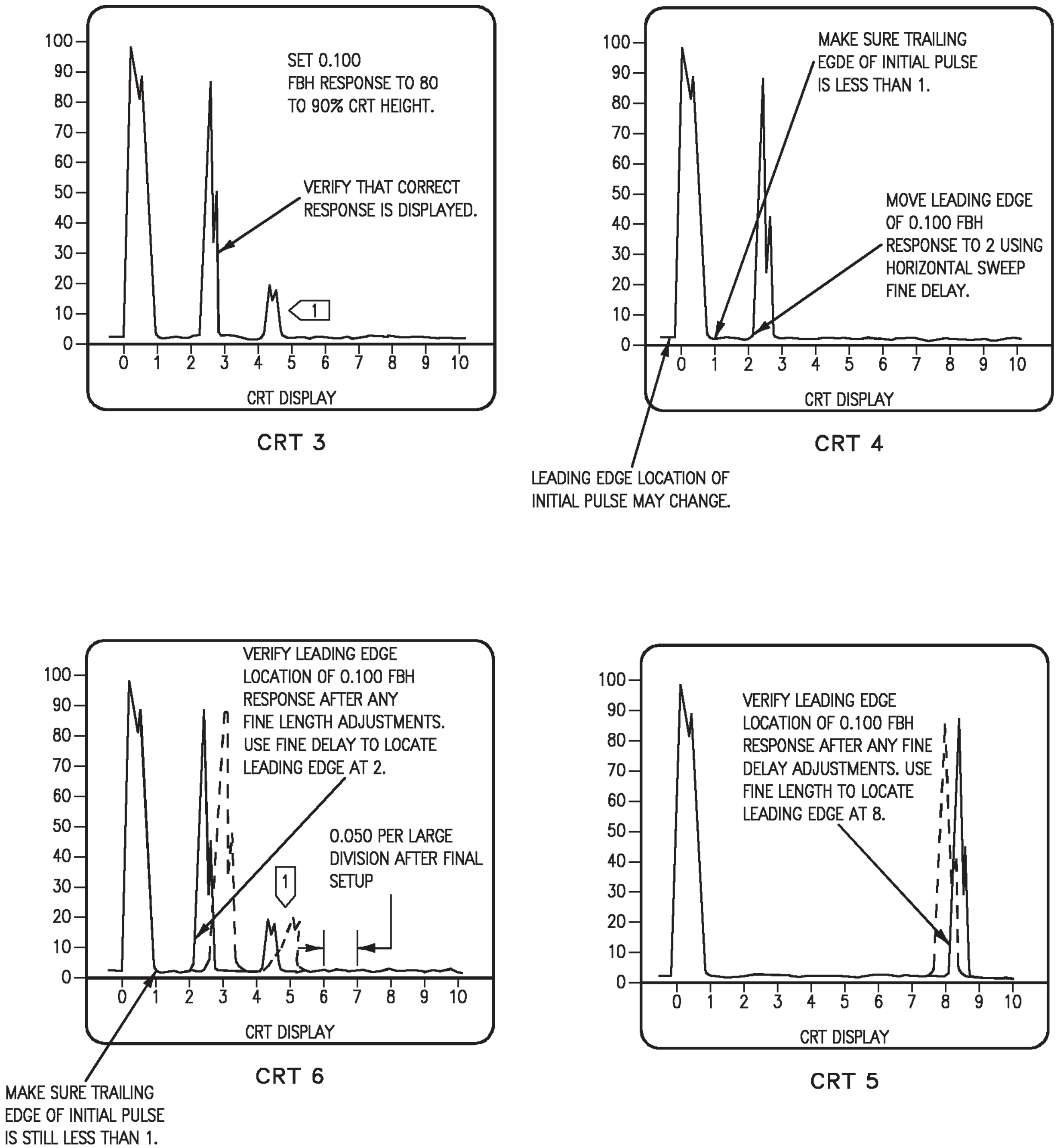
CRT 1



CRT 2

18AC-SRM-30-(411-1)31-CATI

Figure 2. Setup For 0.450 Inch Composite (Sheet 1)



LEGEND

1 MULTIPLE OF 0.100 FBH
MAY OR MAY NOT APPEAR.

18AC-SRM-30-(411-2)31-CATI

Figure 2. Setup for 0.450 Inch Composite (Sheet 2)

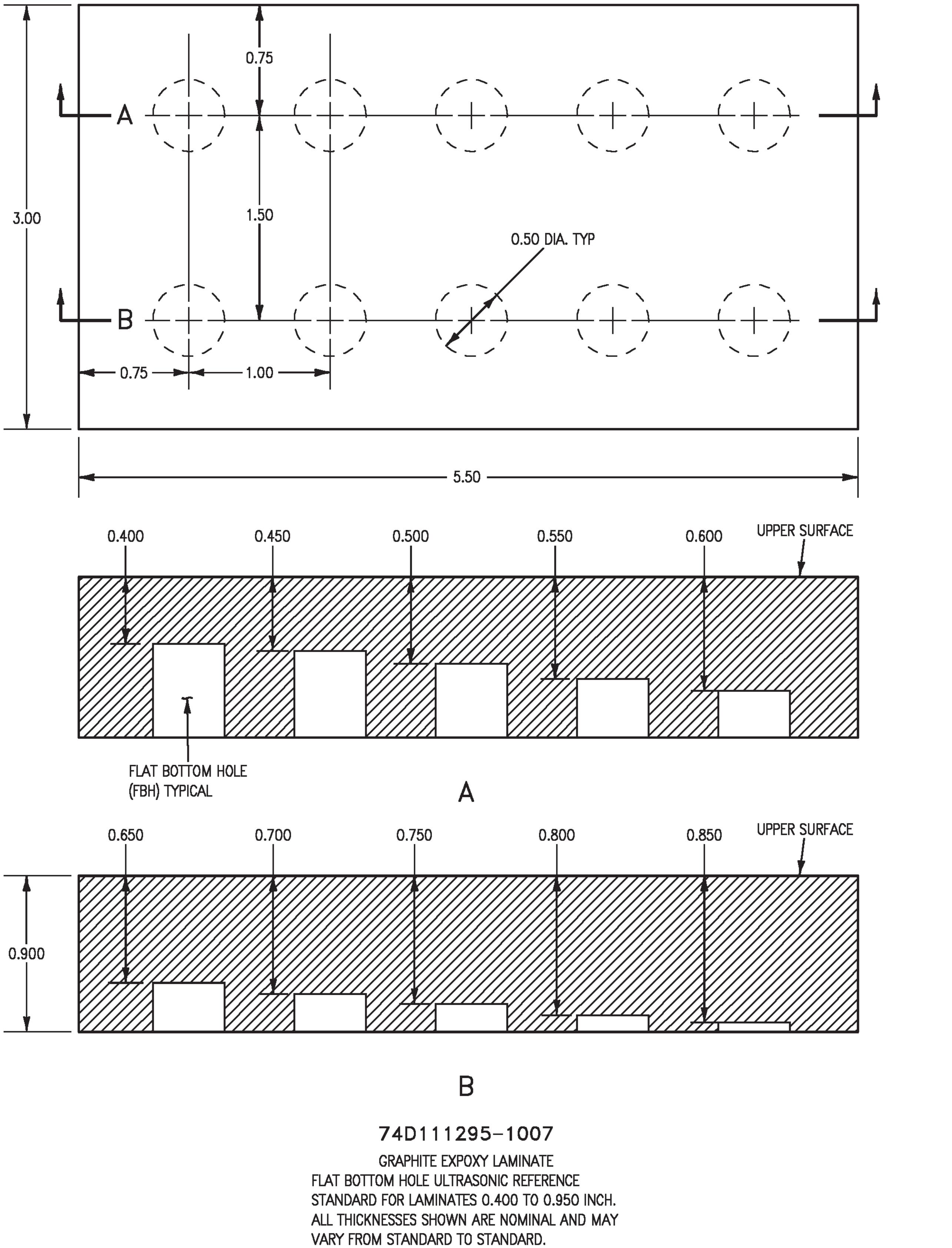
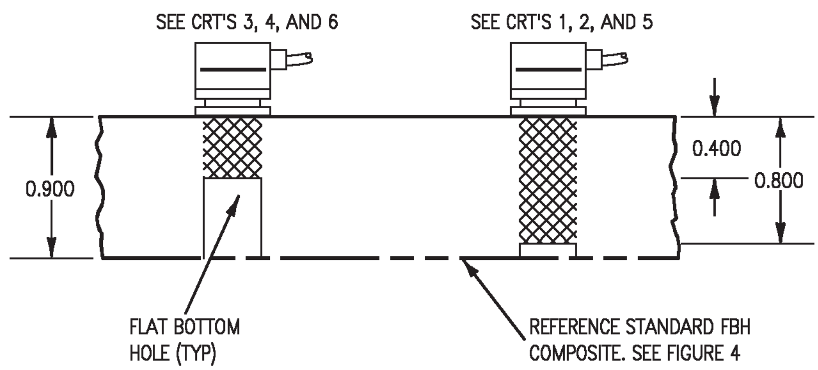
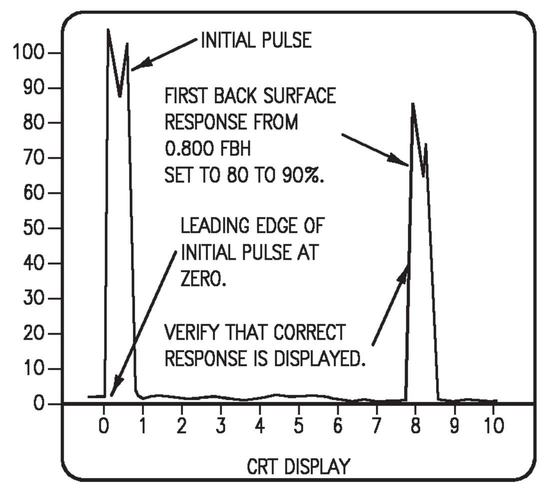
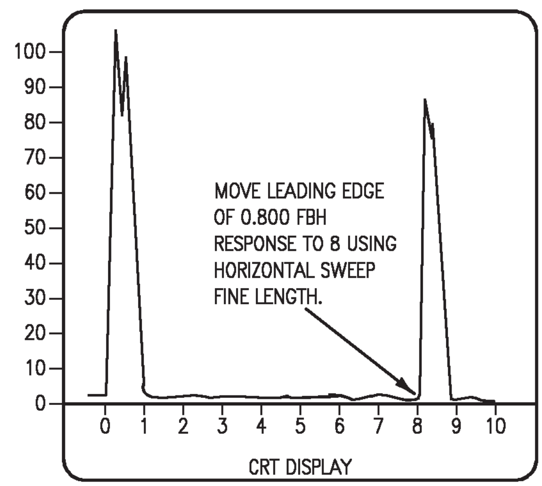


Figure 3. FBH Reference Standard For 0.950 Inch Setup





CRT 1



CRT 2

18AC-SRM-30-(413-1)31-CATI

Figure 4. Setup For 0.950 Inch Composite (Sheet 1)

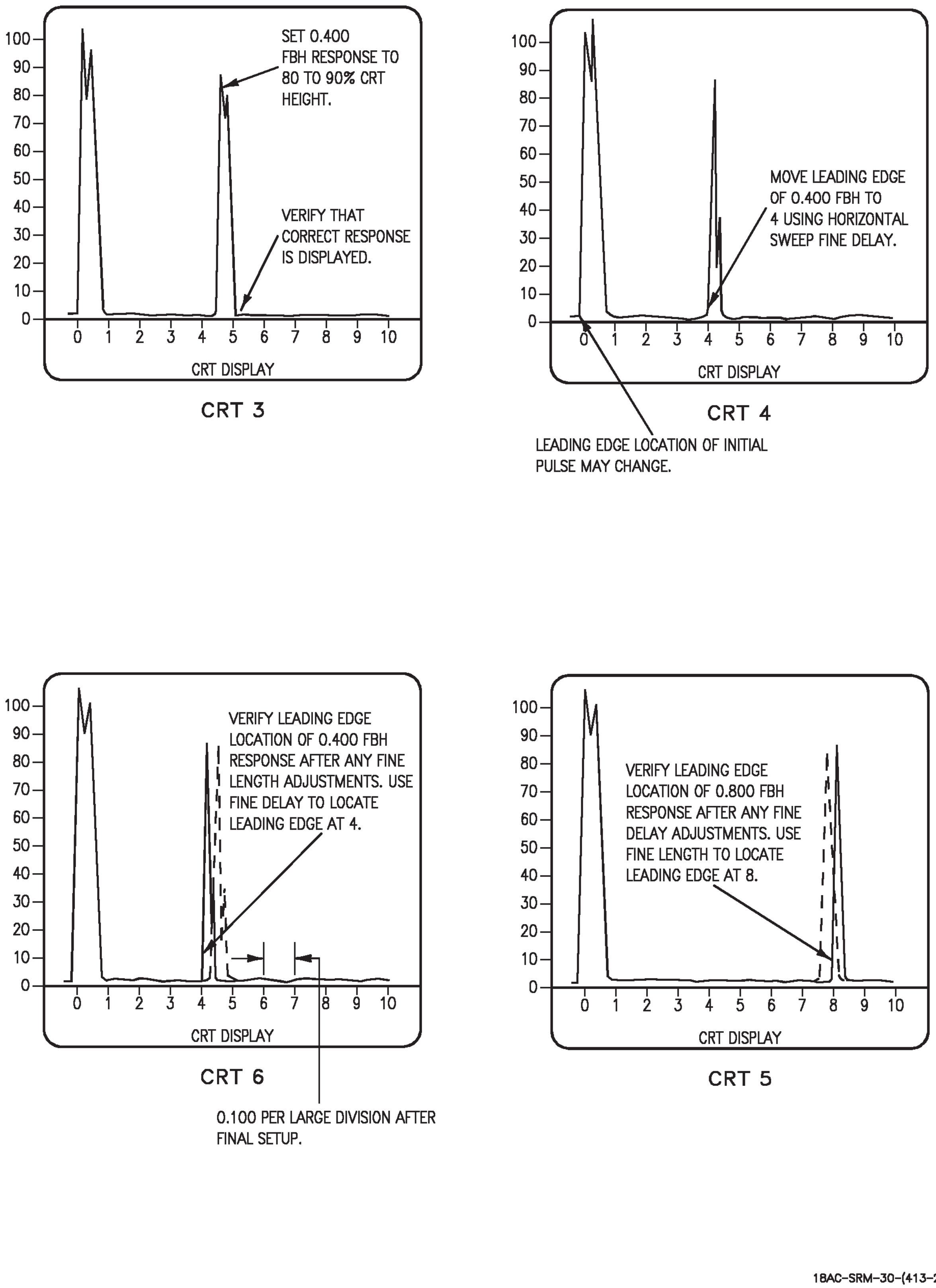


Figure 4. Setup for 0.950 Inch Composite (Sheet 2)

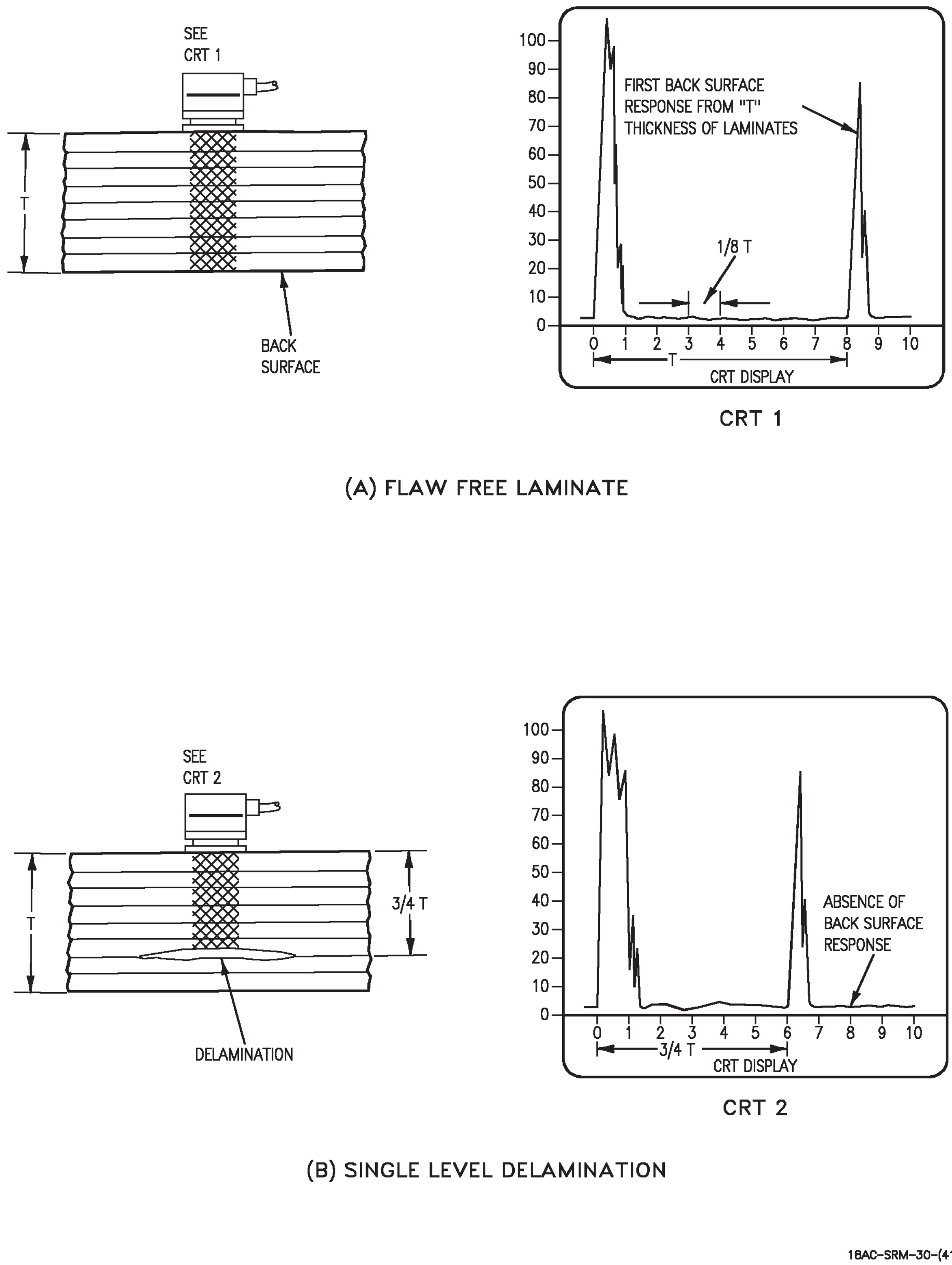
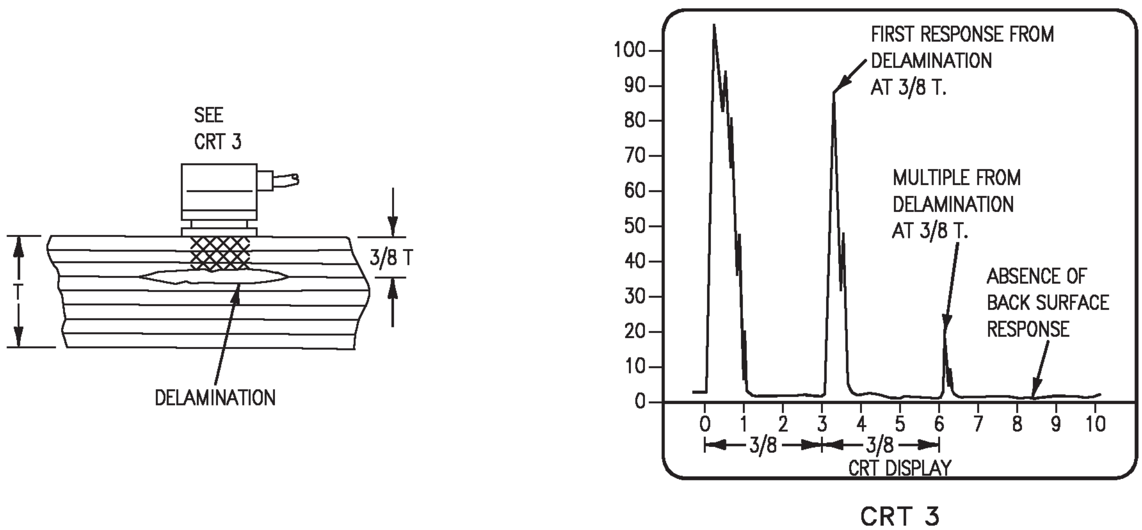
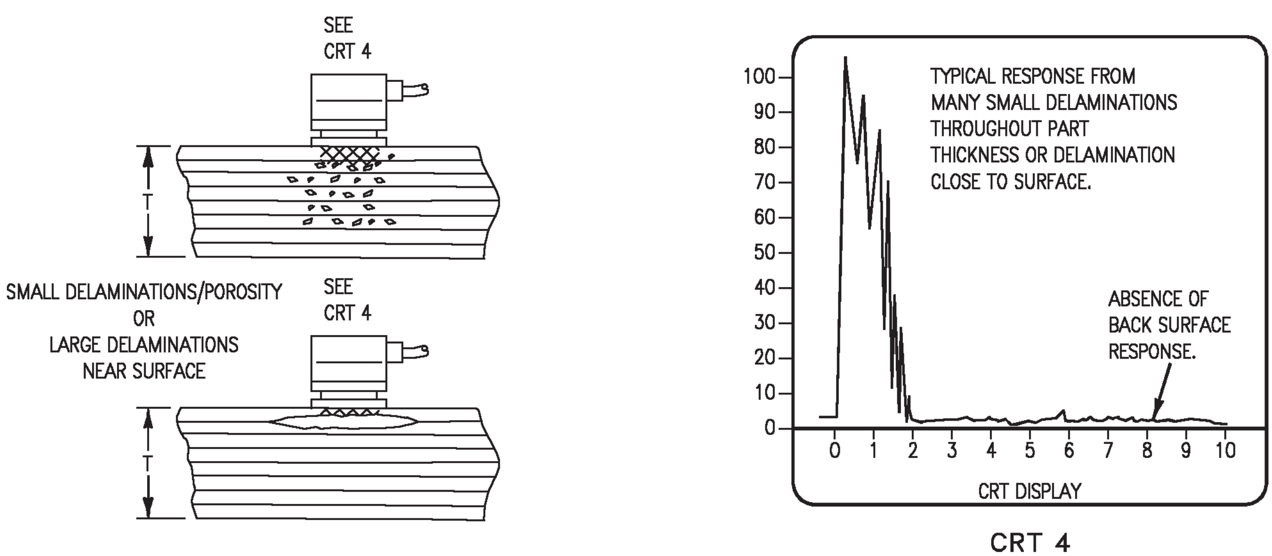


Figure 5. Laminate Inspection Responses (Sheet 1)



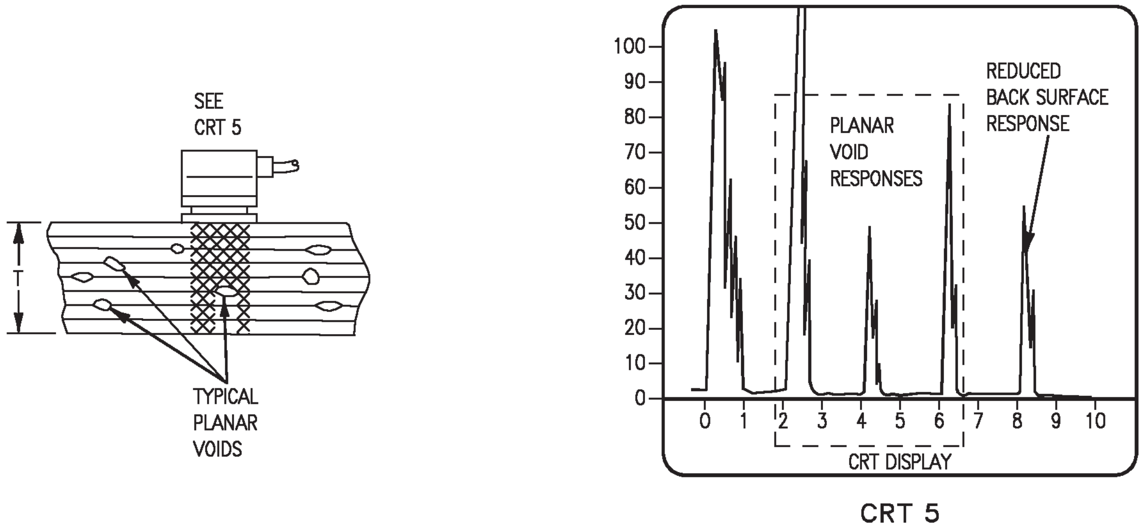
(C) SINGLE LEVEL DELAMINATION AND MULTIPLES



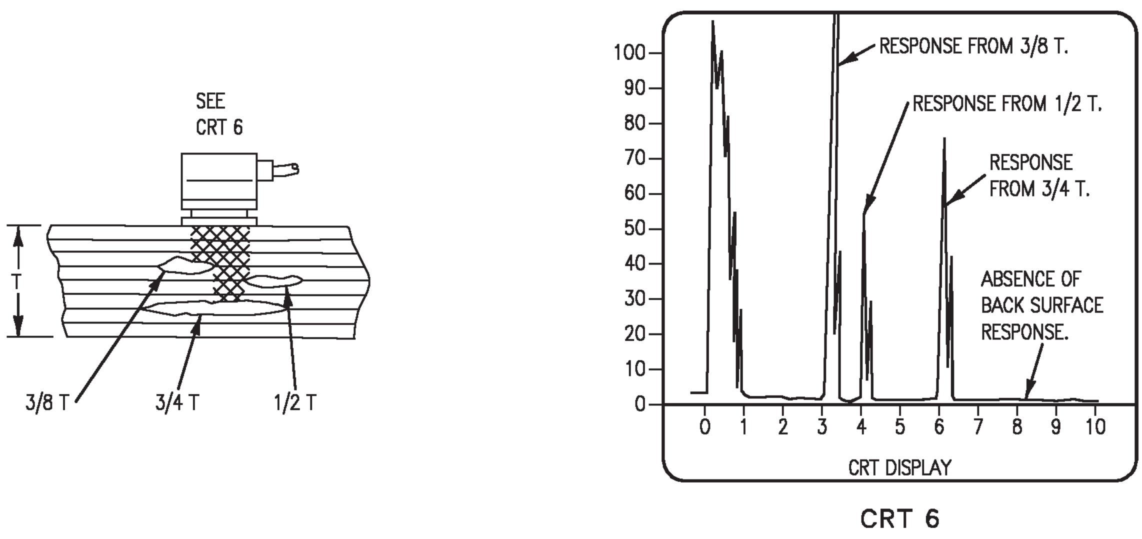
(D) SMALL DELAMINATIONS/POROSITY OR LARGE NEAR SURFACE DELAMINATION

18AC-SRM-30-(414-2)31-CATI

Figure 5. Laminate Inspection Responses (Sheet 2)



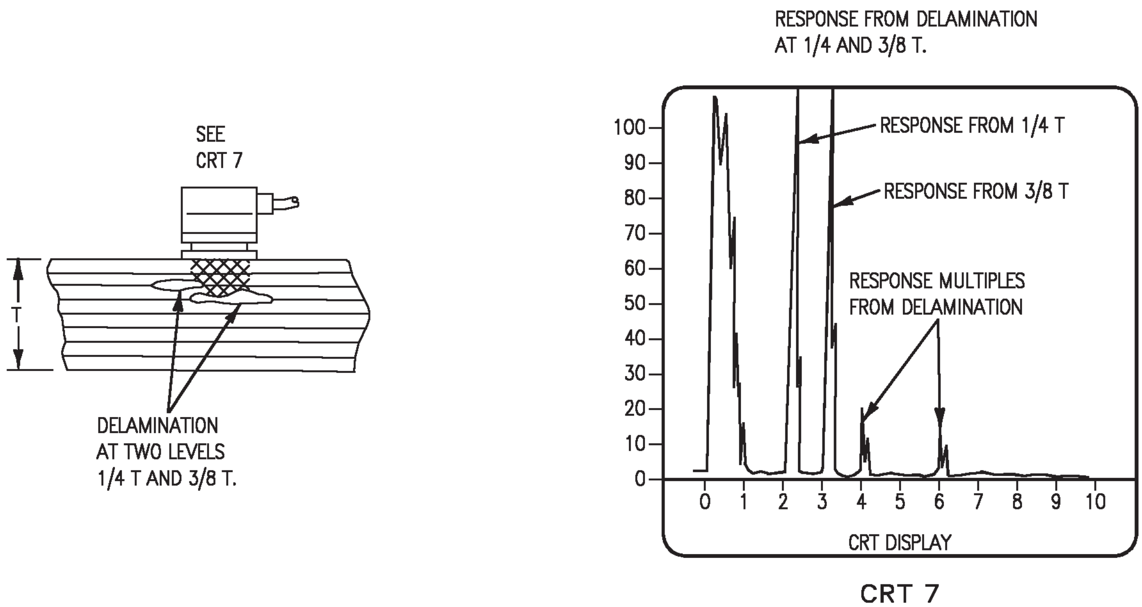
(E) PLANAR VOIDS



(F) MULTIPLE LEVEL DELAMINATION

18AC-SRM-30-(414-3)31-CATI

Figure 5. Laminate Inspection Responses (Sheet 3)



(G) TWO LEVEL DELAMINATION AND MULTIPLES

18AC-SRM-30-(414-4)34-CATI

Figure 5. Laminate Inspection Responses (Sheet 4)

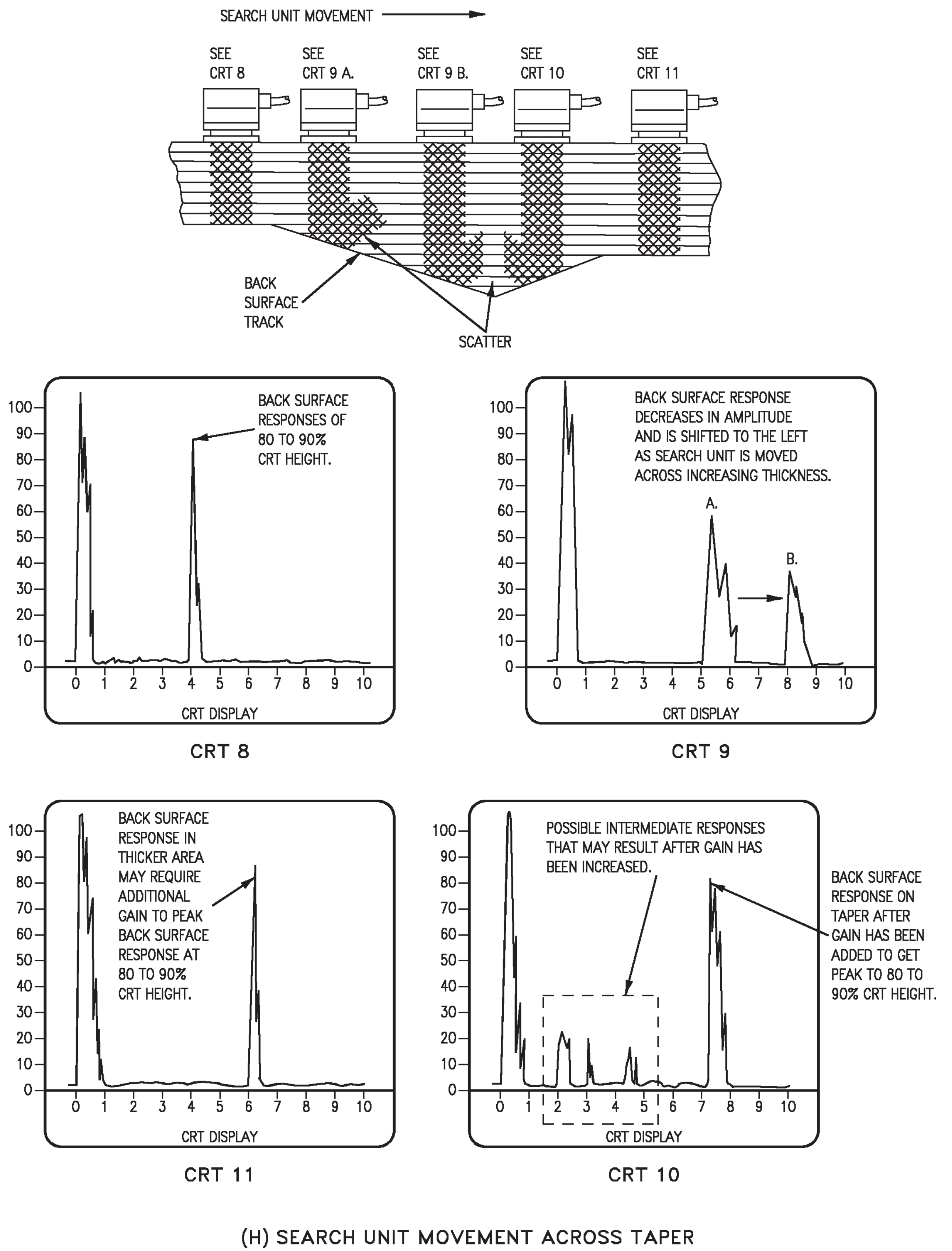
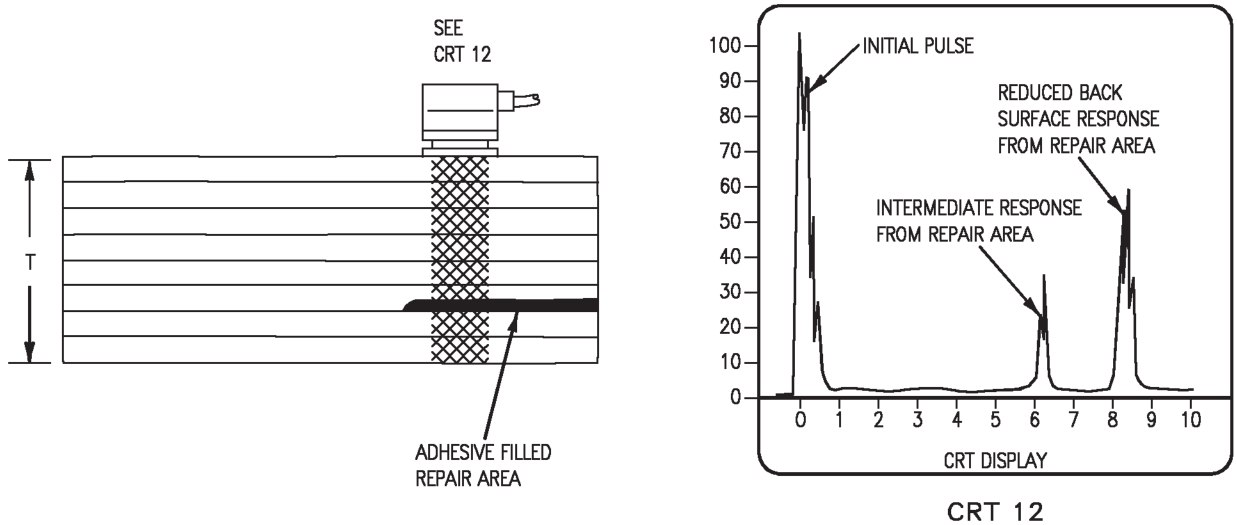
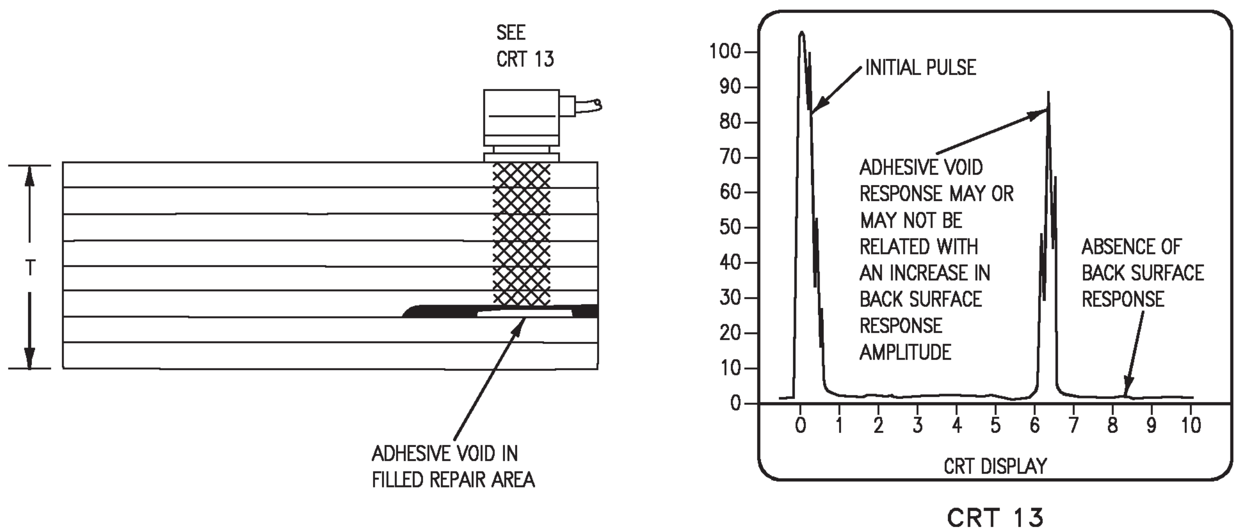


Figure 5. Laminate Inspection Responses (Sheet 5)



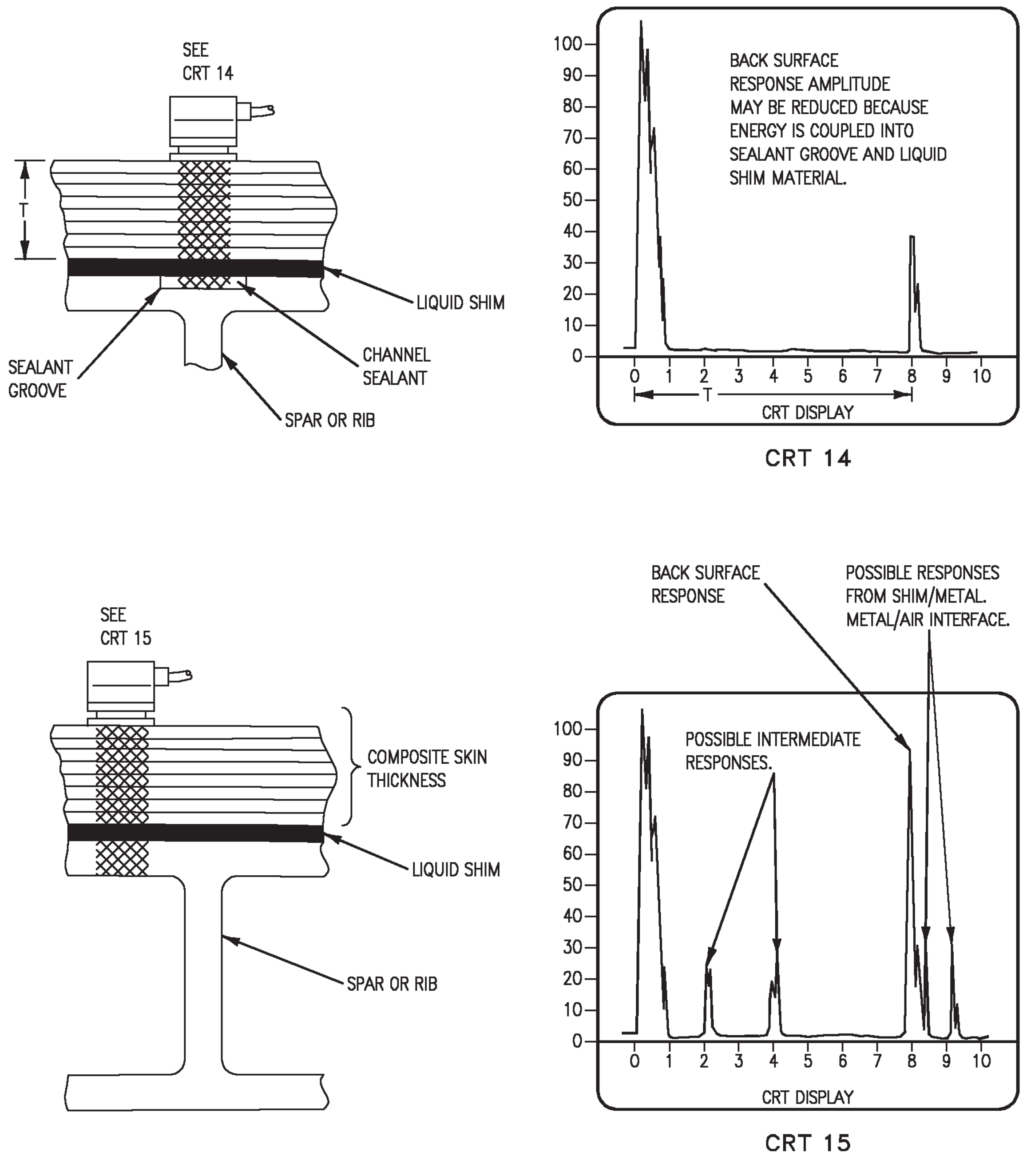
(I) ADHESIVE FILLED REPAIR AREA



(J) ADHESIVE VOID IN FILLED REPAIR AREA

18AC-SRM-30-(414-6)31-CATI

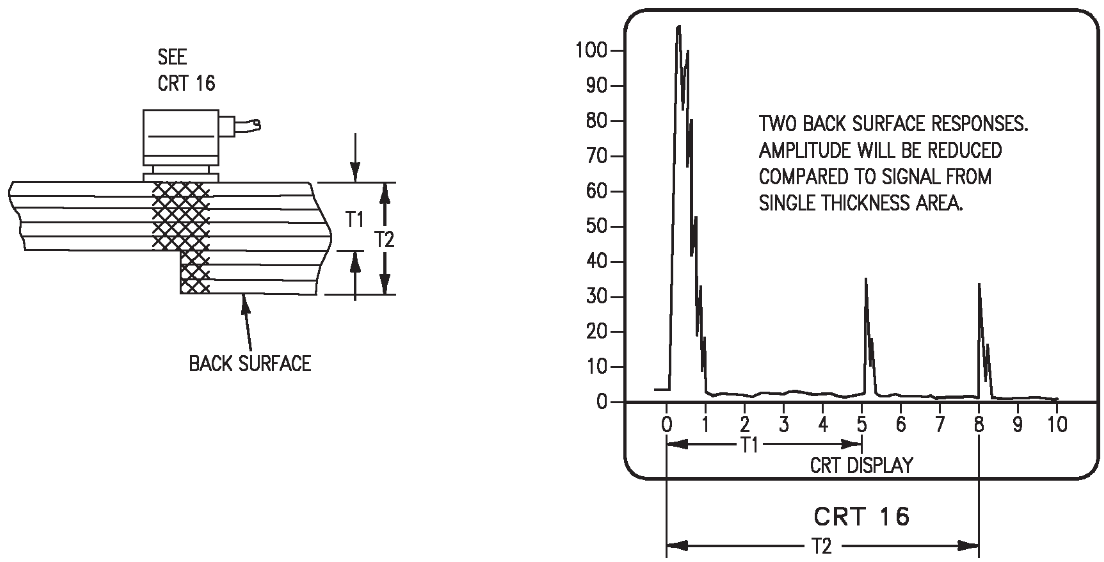
Figure 5. Laminate Inspection Responses (Sheet 6)



(K) AREA CONTAINING LIQUID SHIM

18AC-SRM-30-(414-7)31-CATI

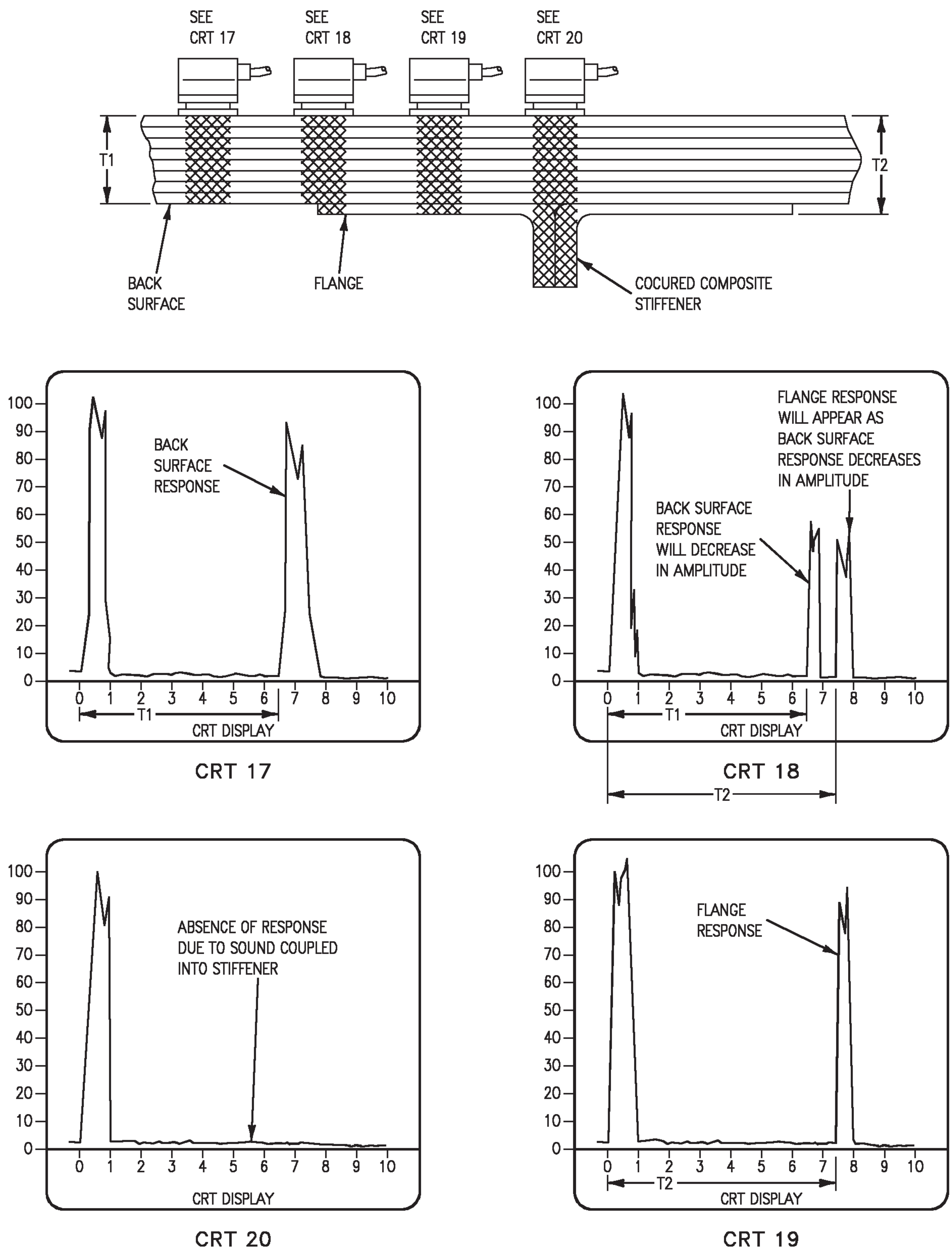
Figure 5. Laminate Inspection Responses (Sheet 7)



(I) THICKNESS CHANGE

18AC-SRM-30-(414-8)31-CATI

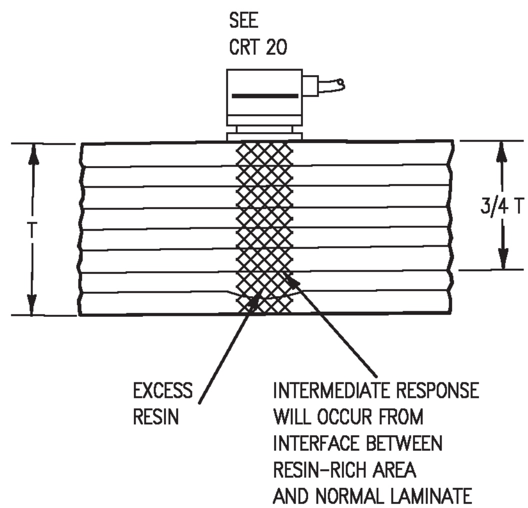
Figure 5. Laminate Inspection Responses (Sheet 8)

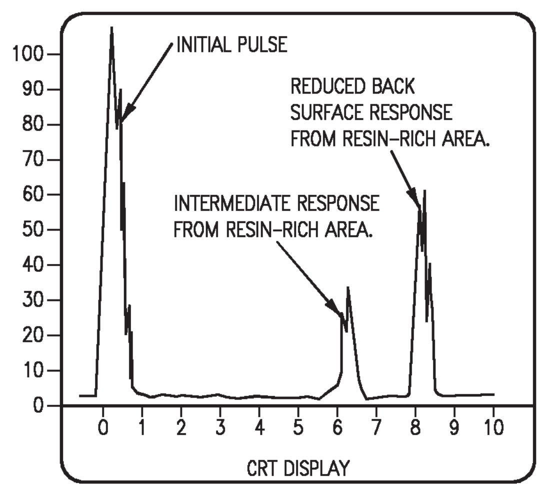


(M) COCURED COMPOSITE STIFFENER

18AC-SRM-30-(414-9)31-CATI

Figure 5. Laminate Inspection Responses (Sheet 9)



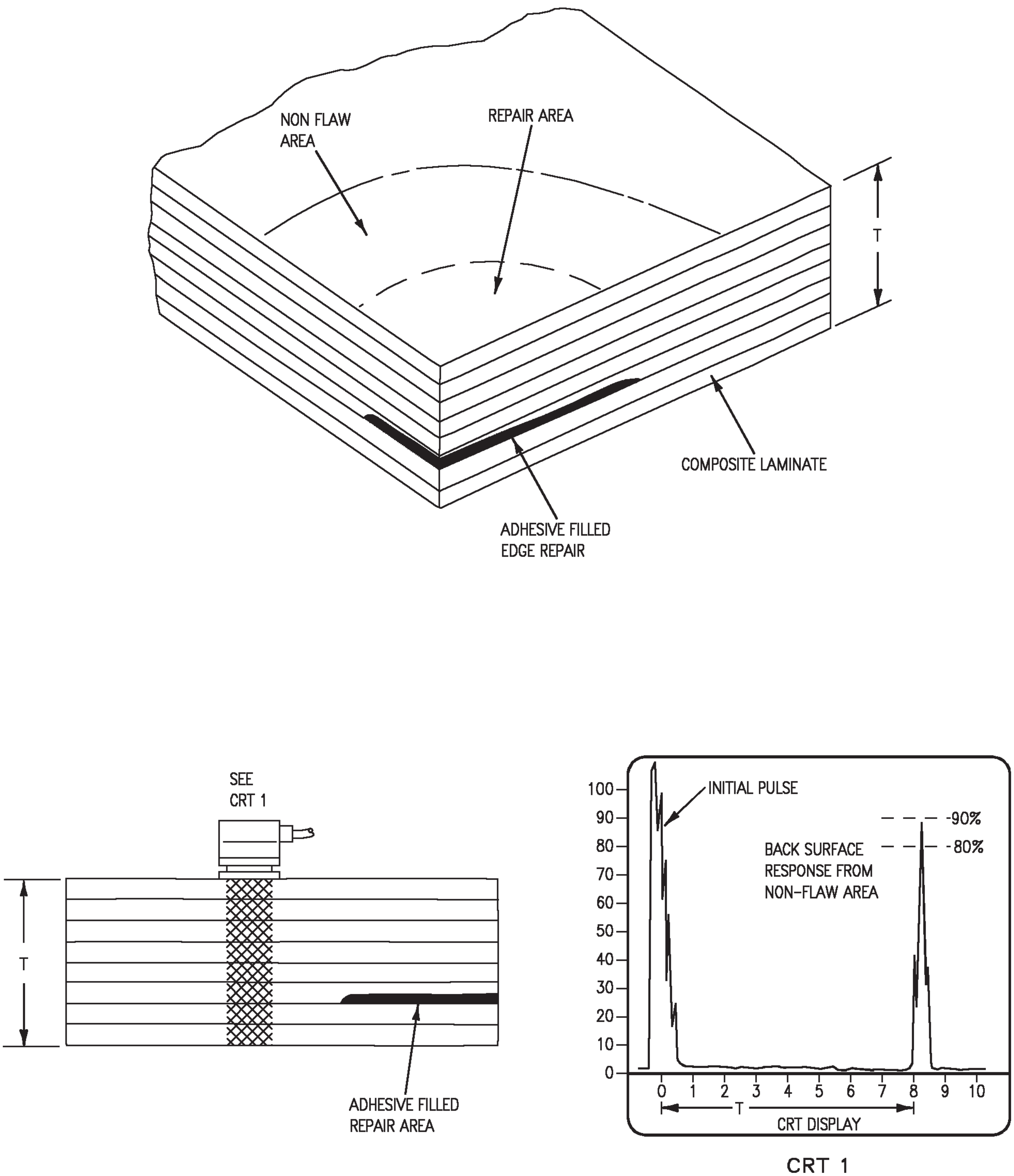


CRT 21

(N) EXCESS RESIN

18AC-SRM-30-(414-10)31-CATI

Figure 5. Laminate Inspection Responses (Sheet 10)



18AC-SRM-30-(415-1)31-SCAN

Figure 6. Edge Fill Repair Inspection

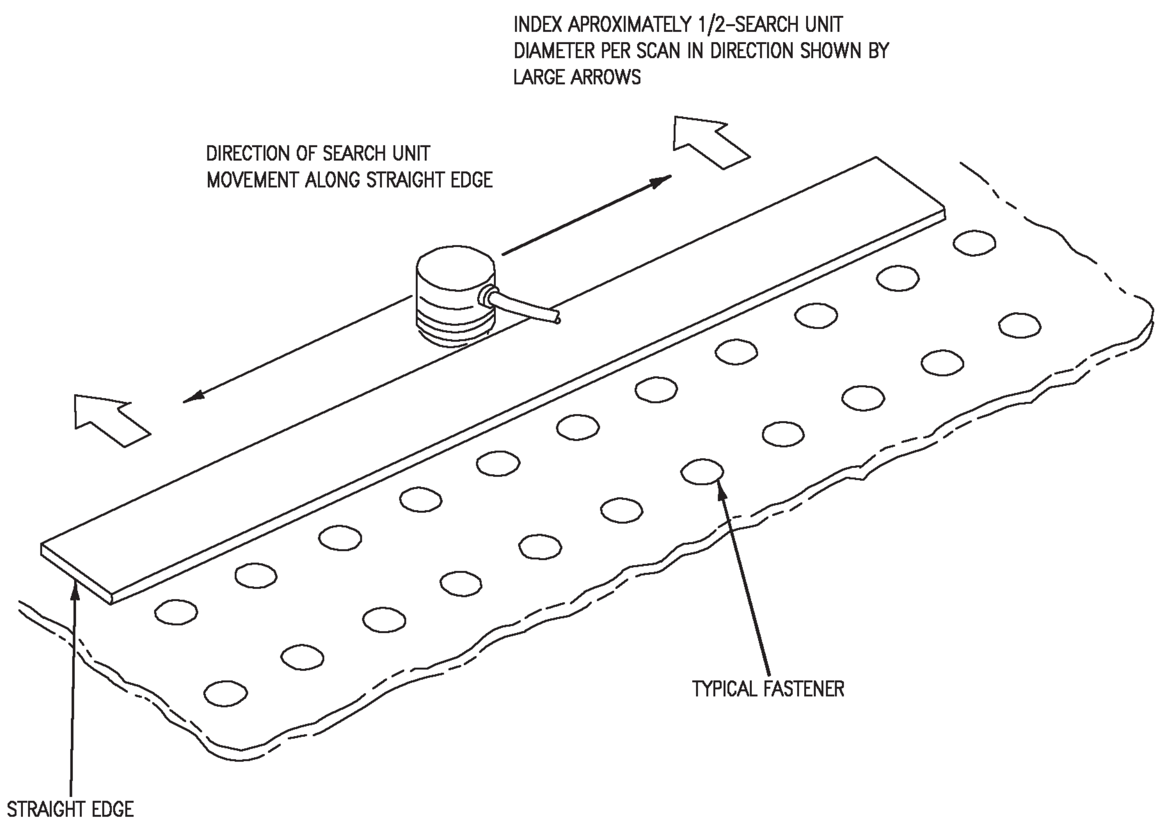
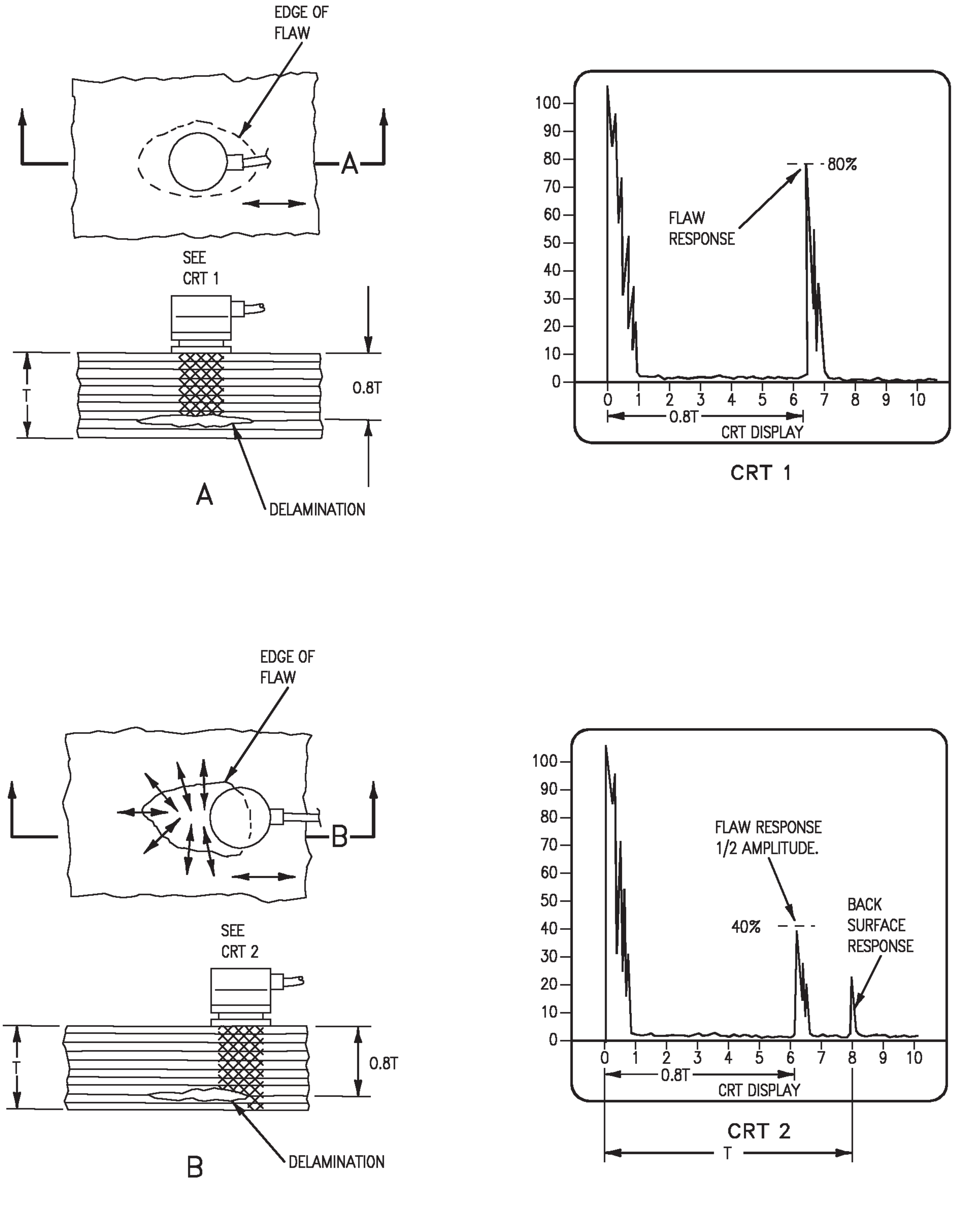
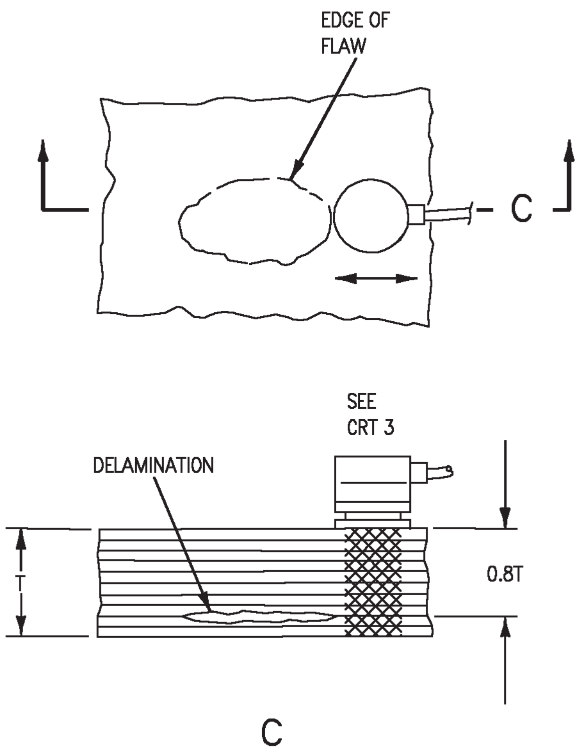


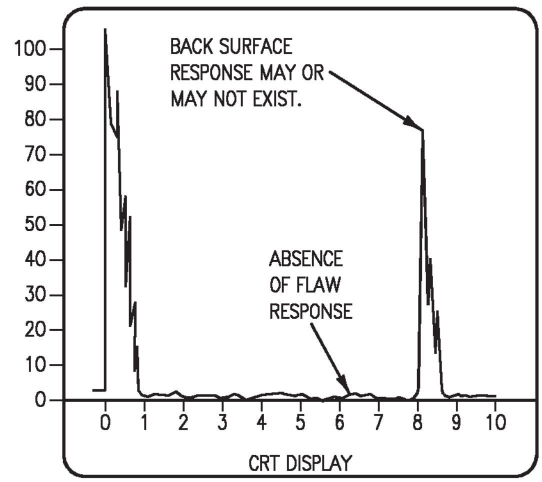
Figure 7. Scanning Method



18AC-SRM-30-(417-1)31-SCAN

Figure 8. Half Amplitude Mapping (Sheet 1)

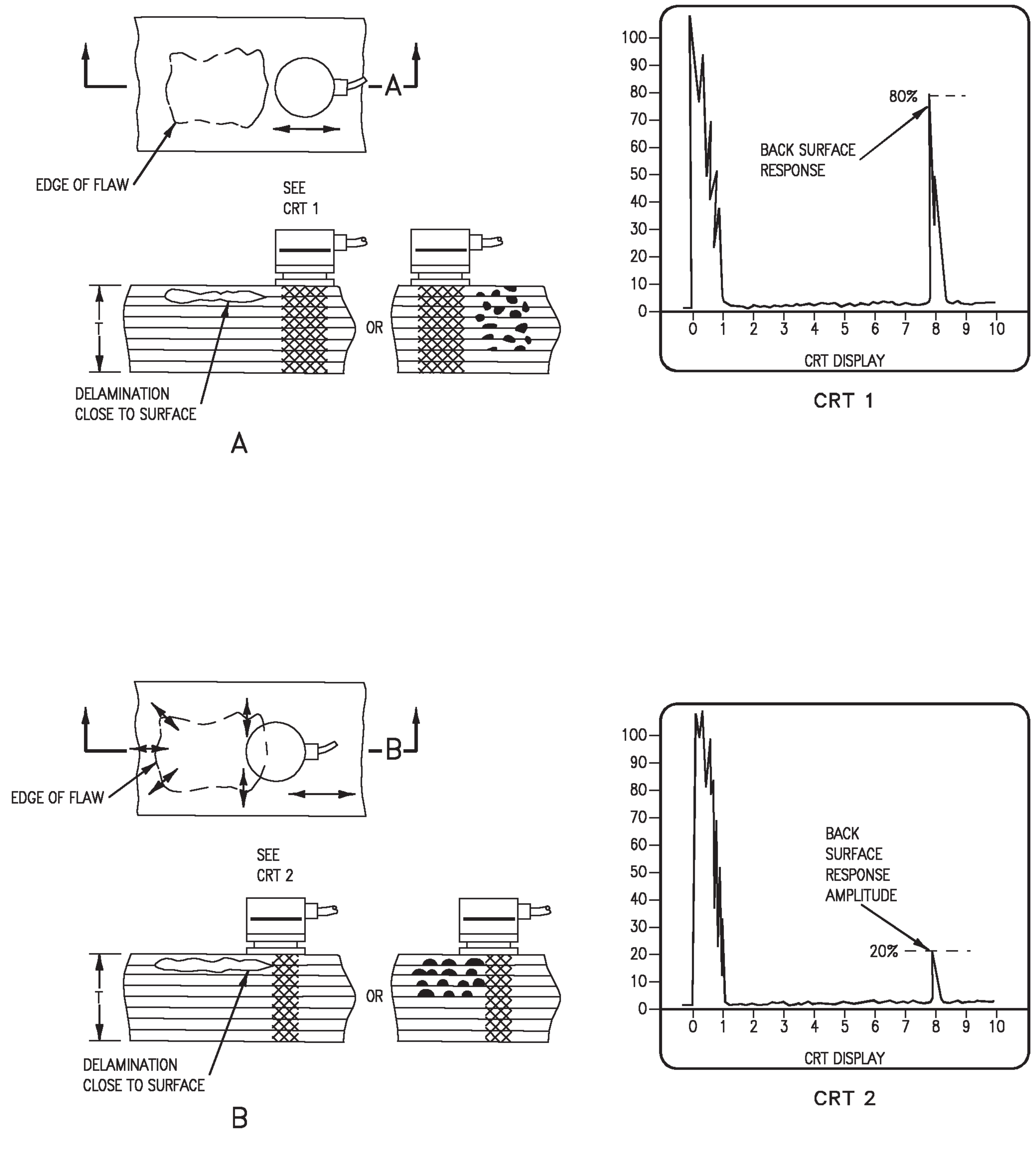




CRT 3

18AC-SRM-30-(417-2)31-SCAN

Figure 8. Half Amplitude Mapping (Sheet 2)



18AC-SRM-30-(418-1)31-SCAN

Figure 9. Amplitude Mapping For Flaws Close to Surface (Sheet 1)

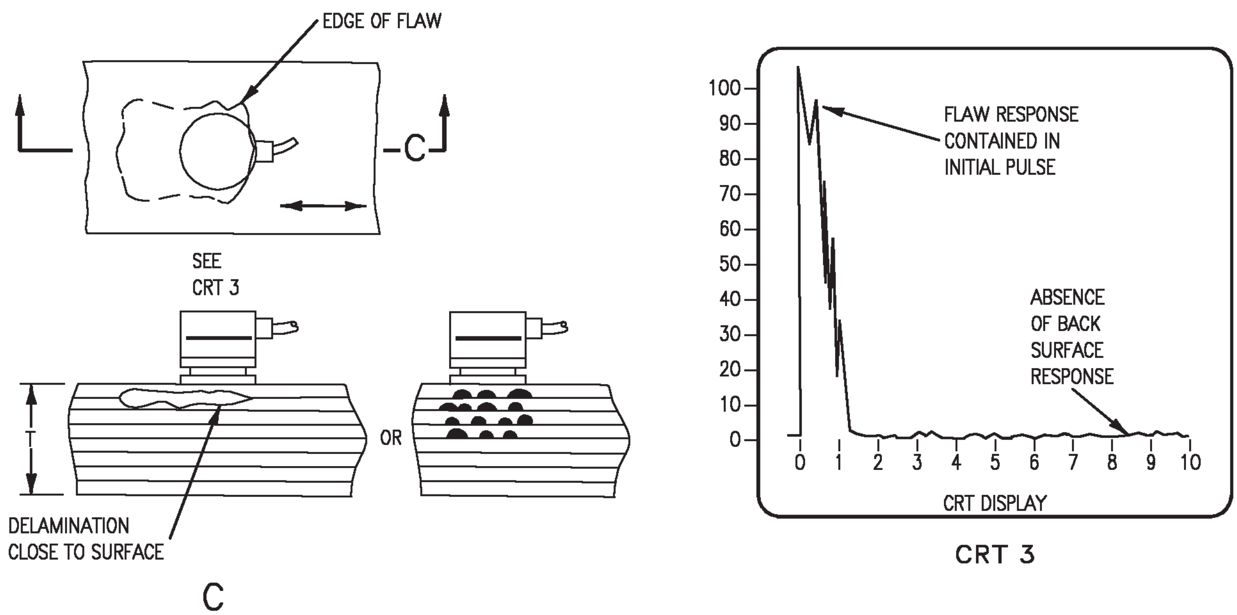


Figure 9. Amplitude Mapping For Flaws Close to Surface (Sheet 2)

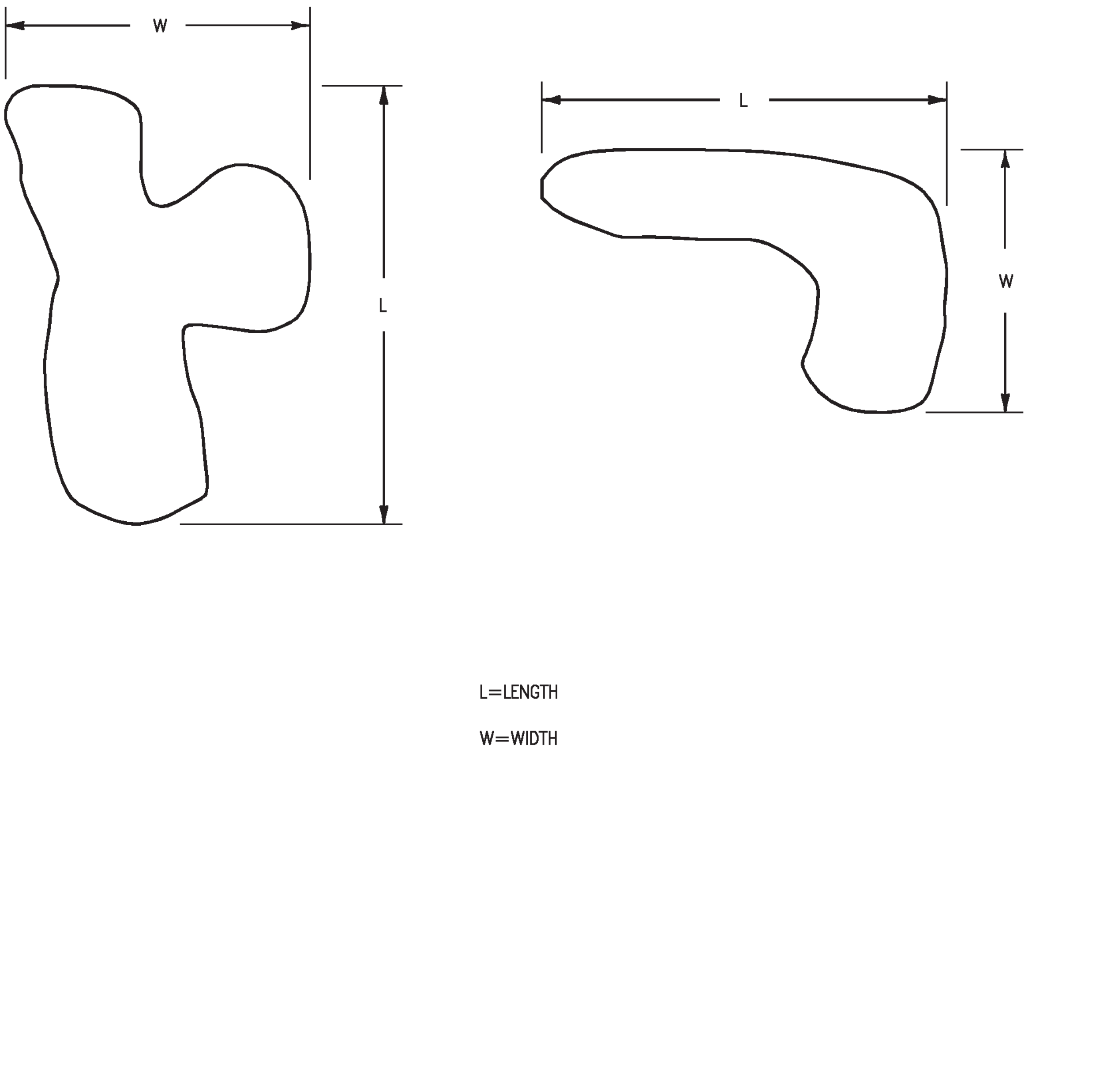


Figure 10. Half Amplitude Mapping, Smooth Curve

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO LONGITUDINAL, CONTACT, WITH DELAY LINE, FOR COMPOSITE LAMINATE MATERIALS

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed, longitudinal, ultrasonic waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Delay line is used as standoff and often improves near surface resolution.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical (static) grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2, NDI Technicians, NEC

7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
GD 0504 or EQUIVALENT	0°, 0.250 Dia, 5 MHz, Contact Delay Line Search unit
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE I, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect each search unit to Microdot connector on connecting cable.

b. Connect BNC end of connecting cable to T or R BNC jacks on tester.

c. Turn tester ON, allow 5 minutes warm-up.

NOTE

Tester settings listed here are given as initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY, and LENGTH.

d. Set tester front face settings;

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.

HORIZONTAL
SWEEP DELAY
COURSE 5
FINE 9.0
HORIZONTAL
SWEEP LENGTH
COURSE 1
FINE 7.0
POLARITY .... OFF
DISTANCE ECHO
CORRECTION .... OFF

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with water moistened cloth, or cleaning compound, as required, to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline. First response from delay line/air interface may also be visible. See figure 1, CRT 1.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline. Tester is ready for standardization.

NOTE

During damping, amplitude of delay line/air interface response should decrease, but initial pulse amplitude should remain constant.

h. Adjust HORIZONTAL SWEEP FINE LENGTH and DELAY, and GAIN so first delay line/air interface response is visible on CRT horizontal baseline while initial pulse is still visible. Damp end of delay line with finger to get reduction in peak amplitude, and verify correct response is being viewed. See figure 1, CRT 2.

i. After delay line/air interface response has been identified, use HORIZONTAL SWEEP DELAY to locate this response at zero on CRT horizontal baseline. See figure 1, CRT 3.

NOTE

If second delay line/air interface response is not visible, increase GAIN to see if response appears. If increasing GAIN causes second response to appear, first damp transducer with finger to verify response is second delay line/air interface response and is not noise due to increased gain. Next, adjust HORIZONTAL SWEEP LENGTH to locate second delay line/air response off screen. Return GAIN to previous setting.

j. Second delay line/air interface response may be visible if certain settings have been selected. See figure 1, CRT 3. Second response may be moved off CRT or located beyond 10 on CRT horizontal baseline by adjusting HORIZONTAL SWEEP LENGTH. It is desirable to work in time period between first and second delay line interface responses. See figure 1, CRT 4.

k. After making adjustments to move second delay line/air response off CRT screen, make sure first delay line/air interface response is still located at zero on CRT horizontal baseline. Adjust HORIZONTAL SWEEP DELAY to relocate response to zero if it is not. See figure 1, CRT 4. Tester is now ready for time-base standardization.

CAUTION

Do not use grease pencil or otherwise mark on face of CRT filter. Damage to components will occur.

6. **TIME-BASE STANDARDIZATION.**

7. **Composite Laminates Up to 0.190 Inch Thick.** This time base standardization is required because delaminations in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been setup to represent 0.020 inch of material, then unknown response located at 5 large divisions on CRT horizontal baseline represents 0.100 inch of setup material. Full scale response at 10 on CRT horizontal baseline would then be equivalent to 0.200 inch of composite material after setup. Use flat bottom hole (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 1, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard in Figure 2 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, number preceding FBH represents material thickness/depth (inches) above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set, over 0.100 FBH.

c. Position search unit over 0.100 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 3, CRT 1.

e. Damp bottom, or reflecting surface, of FBH to make sure correct response if being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT. Minimum REJECT is recommended.

f. Use DAMP., REJECT and VIDEO DISPLAY FILTER to optimize response and remove couplant from reflecting surface continuing.

g. With response peak located at 80 to 90 percent CRT height, use HORIZONTAL SWEEP FINE LENGTH to locate leading edge of 0.100 FBH response at 5 on CRT horizontal baseline. See figure 3, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.040 FBH.

i. Position search unit over 0.040 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back surface response from 0.040 FBH is 80 to 90 percent CRT height. See figure 3, CRT 3. Response multiples may or may not be visible.

k. Damp bottom, or reflecting surface, of 0.040 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent height, use HORIZONTAL SWEEP FINE DELAY TO LOCATE LEADING EDGE OF 0.040 FBH response at 2 on CRT horizontal baseline. See figure 3, CRT 4.

m. Reposition search unit over 0.100 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position of 0.100 FBH response is still located at 5 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE LENGTH to relocate leading edge of 0.100 FBH response at 5 when response peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 5.

n. After any changes in HORIZONTAL SWEEP FINE LENGTH, reposition search unit over 0.040 FBH and adjust GAIN, probably decrease, so 0.040 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE DELAY to relocate 0.040 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times as required. Verify correct leading edge locations of responses from 0.100 and 0.040 FBHs when peak amplitudes are 80 to 90 percent CRT height after any changes in either HORIZONTAL SWEEP FINE LENGTH or DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminates materials up to 0.190. Each large division on CRT horizontal baseline represents 0.020. See figure 3, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth is accurately known. FBH response leading edge location should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.020 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

r. Tester is now standardized for inspection of composite laminates up to 0.190 inch thick.

8. **Composite Laminates Up to 0.450 Inch Thick.** Time base standardization is required because delaminations in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been set up to represent 0.050 of material, then unknown response located at 5 large divisions on the CRT horizontal baseline represents 0.250 inch of setup material. Full scale response at 10 on CRT horizontal baseline would be equivalent to 0.500 of composite material after setup. Use (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 2, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard of Figure 1 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, number before FBH represents material thickness/depth above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of 74D110175-1001 reference standard set, over 0.400 FBH.

c. Position search unit over 0.400 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.400 FBH is 80 to 90 percent height. See figure 4, CRT 1.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH. Damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

e. Damp bottom, or reflecting surface, of 0.400 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Minimum REJECT is recommended.

f. Use DAMP. and REJECT and VIDEO DISPLAY FILTER to optimize response and remove baseline noise. Remove couplant from reflecting surface before continuing.

g. With response peak located at 80 to 90 percent CRT height, use HORIZONTAL SWEEP FINE LENGTH TO LOCATE leading edge of 0.400 FBH response at 8 on CRT horizontal baseline. See figure 4, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.100 FBH.

i. Position search unit over 0.100 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back response from 0.100 FBH is 80 to 90 percent CRT height. See figure 4, CRT 3.

k. Damp bottom, or reflecting surface, of 0.100 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent height, use HORIZONTAL SWEEP FINE DELAY locate leading edge of 0.100 FBH response at 2 on CRT horizontal baseline. See figure 4, CRT 4.

m. Reposition search unit over 0.400 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position and 0.400 FBH response is still located at 8 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE LENGTH to relocate leading edge of 0.400 FBH response at 8 when response peak amplitude is 80 to 90 percent CRT height. See figure 4, CRT 5.

n. After any changes in HORIZONTAL SWEEP FINE LENGTH, reposition search unit over 0.100 FBH and adjust GAIN, probably decrease, so 0.100 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE DELAY to locate 0.100 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times, as required. Verify correct leading edge locations of responses from 0.400 and 0.100 FBH's when peak amplitudes are 80 to 90 percent CRT height after any changes in either HORIZONTAL SWEEP FINE DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminate materials up to 0.450 inch thick. Each large division on CRT horizontal baseline divisions represents 0.050 inch of material. See figure 4, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth are accurately known. FBH response leading edge should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.050 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

r. Tester is now standardized for inspection of composite laminates up to 0.450inch thick.

9. **INSPECTION PROCEDURES.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

b. Before beginning inspection, determine locations of ply changes, rabbets, stiffeners, and other items lying beneath surface of area to be inspected. This information should be described in specific procedure work packages. Lay out locations of ply changes, rabbets, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar overlay. Also include applicable thicknesses of part or areas of part on overlay.

c. To make sure large parts are completely inspected, mark grid pattern(s) on inspection area per specific work package using aircraft marking pencil and straight edge. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 inch grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5, 6, 7, and 8 for composite thickness of part being inspected.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit face wear should be parallel to back surface of laminate. See figure 5, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 5, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 of search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 6. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid block.

i. Use guidelines given in paragraph 10 on CRT interpretation to identify flaws.

j. Once flaw has been identified, use pulse-echo mapping technique shown in figure 7 and described in paragraph 20.a. for 1/2 amplitude mapping, and figure 8, paragraph 20. b. for mapping flaws close to surface or small multiple delaminations to determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge or by using delay line technique when defect is closer to surface.

k. Mark all flaw indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

10. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, back surface response, and possibly back surface response multiples should be visible on CRT. Back surface response should be located at CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 5, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed before inspection, described in paragraphs 5, 6, 7, and 8.

11. **Single Level Delamination .** A delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 5, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 5, CRT 3.

12. **Small Delaminations and Large Near Surface Delaminations.** Small delaminations throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 5, CRT 4.

NOTE

If not clear whether indication is due to near surface delamination or presence of heavy porosity, and back surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates that delamination is present. If small response is detected, it is likely that area contains heavy porosity.

13. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate response may be due to numerous planar voids and multiples from single planar voids. See figure 5, CRT 5.

14. **Multiple Level Delaminations.** Appearance of more than one intermediate response and absence of back-surface response may indicate multiple level delamination. See figure 5, CRT 6. Depending on depth of each delamination level, multiples from various levels may also appear. See figure 5, CRT 7.

NOTE

Too much gain may result in sensitivity level where meaningless responses will appear. Increasing gain may get intermediate response multiples.

15. **Tapers.** Tapers should be described in specific work package or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-700 through A1-F18AE-SRM-750). When search unit is placed over area outside of taper, where front and back surfaces of part are parallel, back surface response will appear at CRT horizontal baseline corresponding to part thickness at that point. Gain should be adjusted so back surface response at such point is 80 to 90 percent CRT height. See figure 5, CRT 8. As search unit is moved across area of taper in which thickness of part is increasing, back surface response will decrease in amplitude and move away from initial pule. See figure 5, CRT 9. As search unit is moved across area of taper in which thickness of part is decreasing, back surface response will increase in amplitude and move toward initial pulse. If back surface amplitude is significantly decreased due to added thickness on taper, increase gain so back surface response is back up to 80 to 90 percent CRT height. See figure 5, CRT 10. Depending on the new part thickness when taper ends, gain may need to be adjusted again so back surface response is 80 to 90 percent CRT height. See figure 5, CRT 11. Intermediate responses may appear when gain is increased.

16. **Edge Repair.** Adhesive filled edge repair area will result in intermediate response from repair area and reduction in back surface amplitude due to attenuation from repair area. See figure 5, CRT 12. Repair area containing adhesive void will be indicated by intermediate response and absence of back surface response. Increase in amplitude of intermediate response compared flaw free repair area response is likely, but may not always happen. See figure 5, CRT 13.

17. **Liquid Shim.** When search unit is placed over laminate containing liquid shim between skin and substructure, several responses are possible. When search unit is placed over sealant groove, back surface amplitude may be reduced since energy is coupled into liquid shim and channel sealant. See figure 5, CRT 14. In other areas, where there is liquid shim between laminate and substructure, back surface response may be decreased in amplitude, since some energy is coupled into shim and substructure. Reflections from shim/substructure and substructure/air interfaces may appear. See figure 5, CRT 15. Rather than appearing as distinct responses to left of back surface response, back surface response be broadened and decreased in amplitude due to reflections from shim/substructure and substructure interfaces.

NOTE

When inspecting areas containing liquid shim, it may be required to increase gain to peak back surface response. Intermediate responses may occur when gain is increased.

18. **Abrupt Thickness Change.** Locations of abrupt thickness changes should be noted in specific work packages or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750). When search unit is placed over area containing thickness change, back surface response from each thickness will appear.

Amplitude of each response will be reduced compared to signal from single thickness area. See figure 5, CRT 16.

19. **Cocured Composite Stiffener.** As search unit is moved across area containing cocured composite stiffener, variety of responses will occur. See figure 5, CRTs 17 through 20. Before search unit is placed over underlying stiffener, there should be back surface response, its amplitude between 80 and 90 percent height located at CRT horizontal baseline representing its thickness, T1. See figure 5, CRT 17. Moving search unit across laminate surface so it covers part of underlying composite flange, back surface response will decrease in amplitude as flange response appears. With half of search unit covering flange, both back surface and flange responses will have decreased amplitudes compared to original back surface response. Flange response will be located at CRT horizontal baseline location representing T2, sum of laminate and flange thicknesses. See figure 5, CRT 18. Depending on laminate and flange thicknesses as well as tester settings, laminate and flange responses may not be distinct so only one broadened response with reduced amplitude appears. When search unit is moved completely over flange, back surface response may completely disappear so only flange response appears. Flange response should have increased amplitude compared to responses when half of search unit covered flange, and should be located at CRT horizontal baseline division representing T2. See figure 5, CRT 19. Depending on thicknesses and flaw detector settings, small back surface response may still be present. When search unit is placed directly over stiffener, response may completely disappear since ultrasonic energy is coupled into stiffener. See figure 5, CRT 20. If stiffener is unbonded from laminate, back surface response will appear and will be located at CRT horizontal baseline division representing T1, laminate thickness. Amplitude of this response will depend on size of unbond, void, etc. at interface since defect size will determine amount of ultrasonic energy that is coupled into stiffener. Even if there are no defects at stiffener/back surface interface, small back surface response may be received at T1 location on CRT horizontal baseline.

20. **MAPPING.**

a. Half Amplitude Mapping.

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent CRT height. See figure 7, CRT 1.

(3) Move search unit toward good areas in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2-amplitude. See figure 7, CRTs 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping For Flaws Close to Surface or Small Multiple Delaminations.

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 8, CRT 1.

(3) Move search unit in toward flaw in all directions. Use aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent of CRT height. See figure 8, CRTs 2 and 3.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 9.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

21. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part.

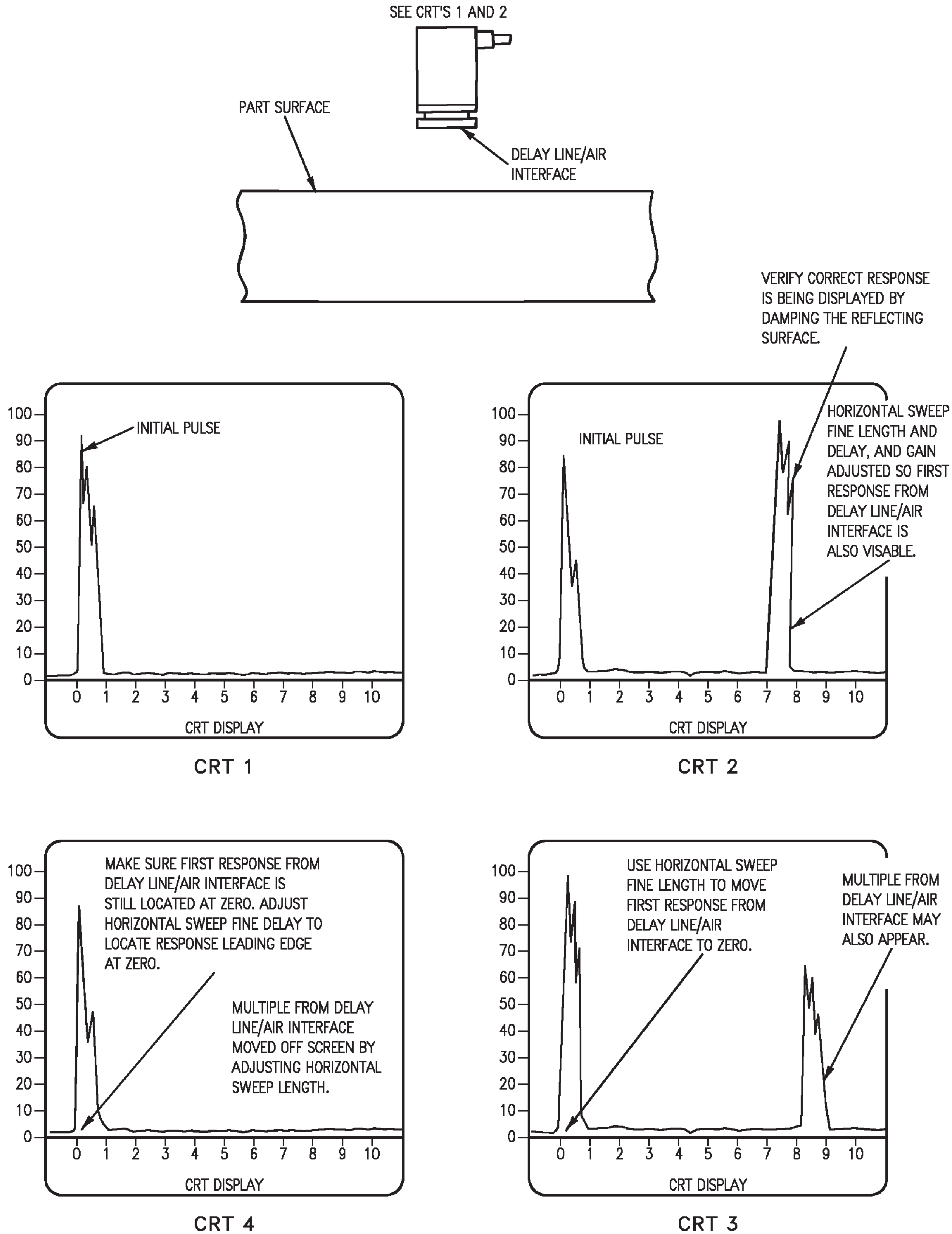
NOTE

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

22. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to dry for 15 minutes after cleaning.



18AC-SRM-30-(420-1)31-SCAN

Figure 1. Initial Setup, 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit

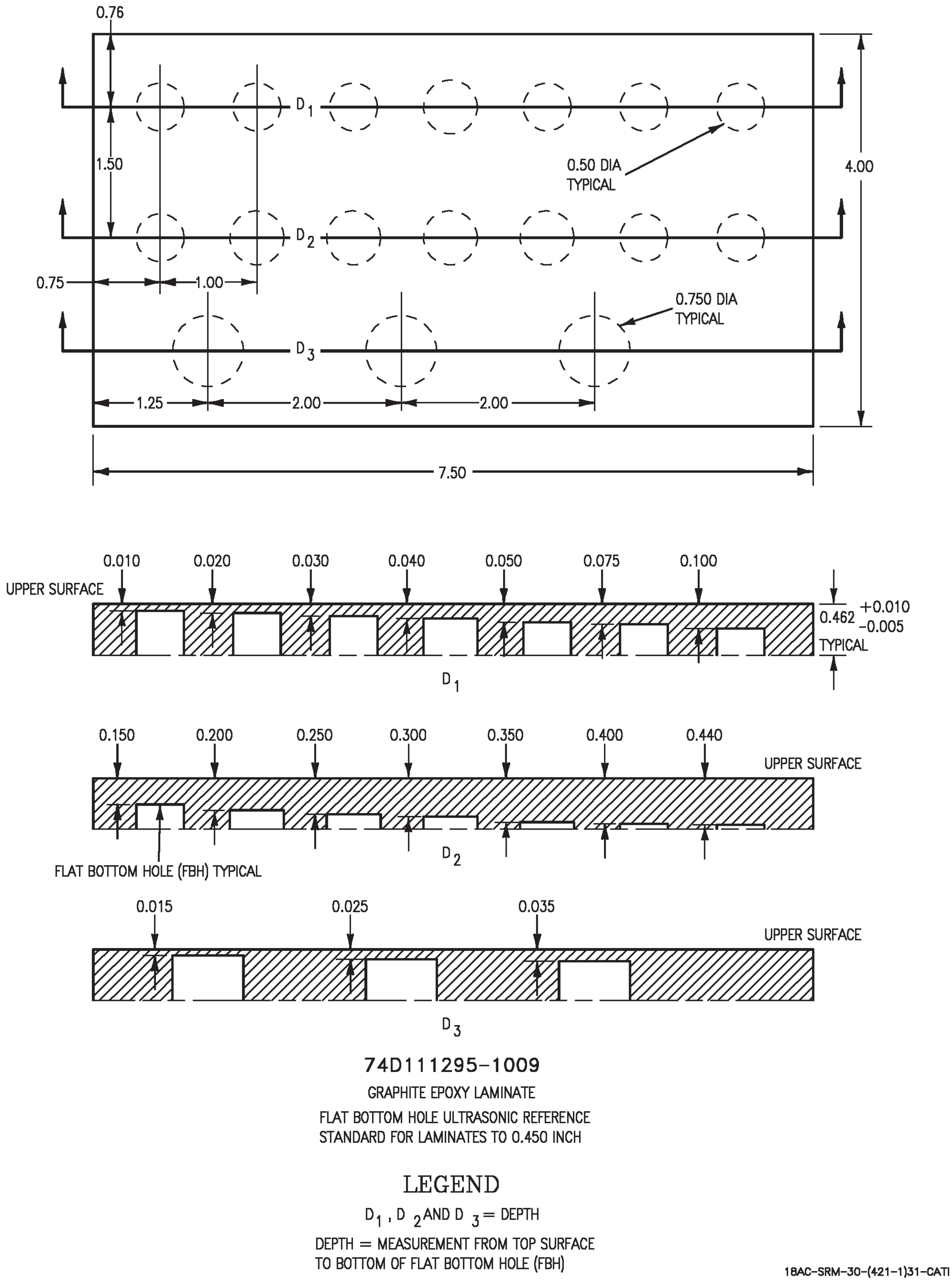
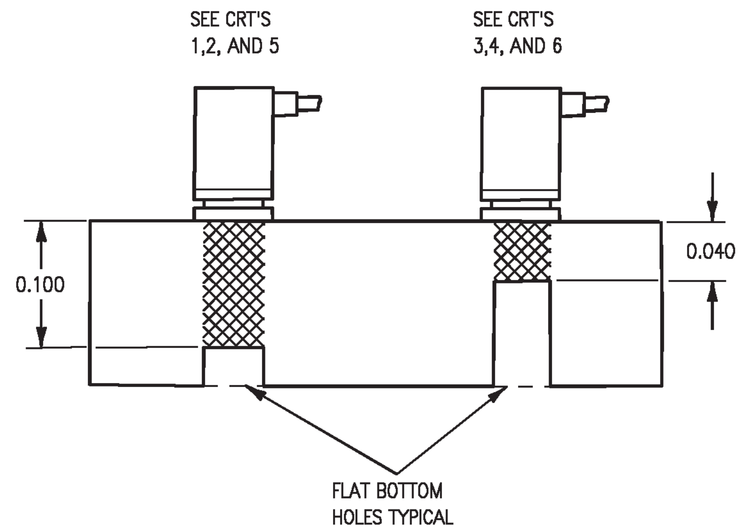
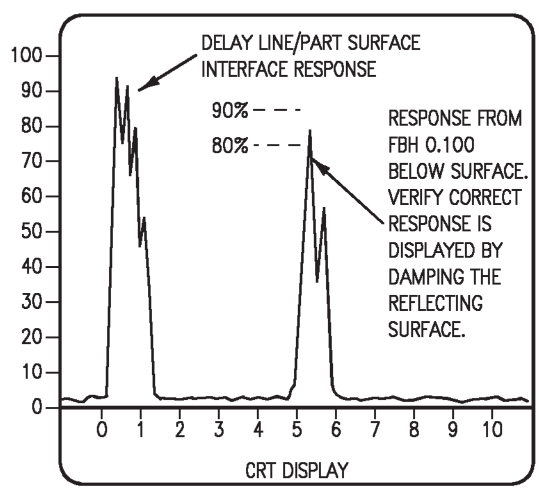
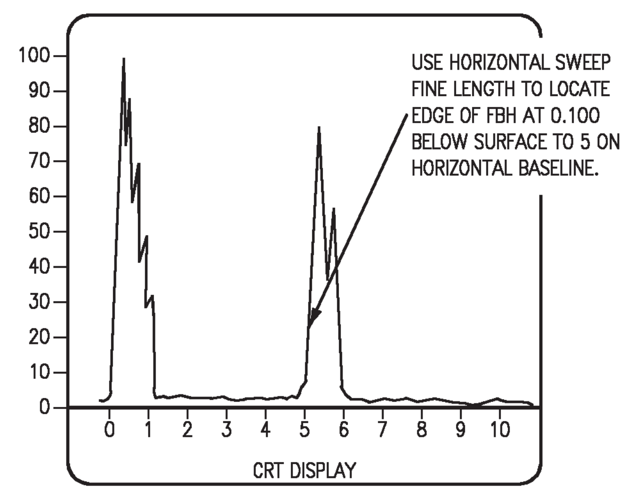


Figure 2. FBH Reference Standard for Delay Line Setup





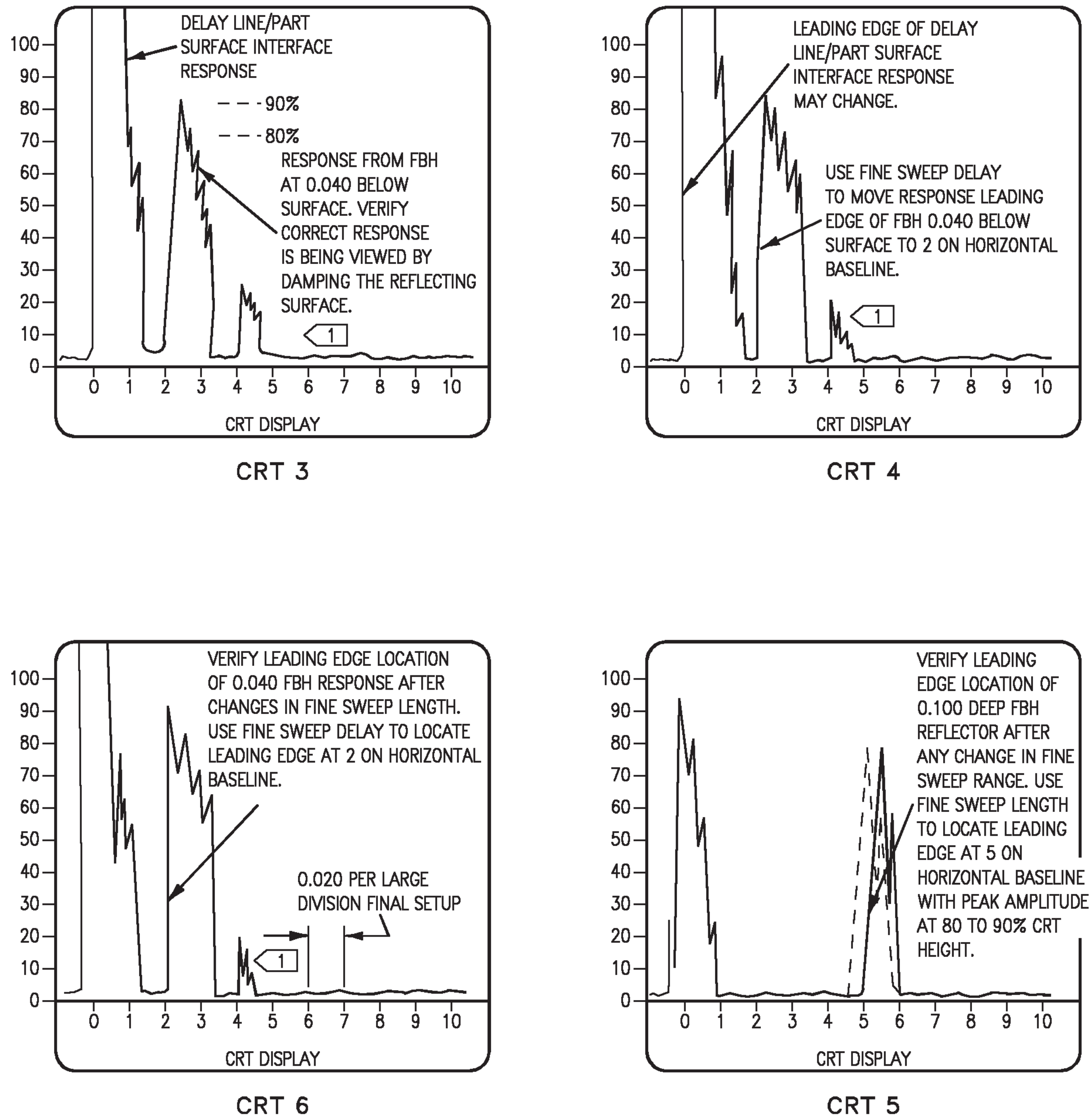
CRT 1



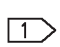
CRT 2

18AC-SRM-30-(422-1)31-SCAN

Figure 3. Composite Setup for 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit (Sheet 1)



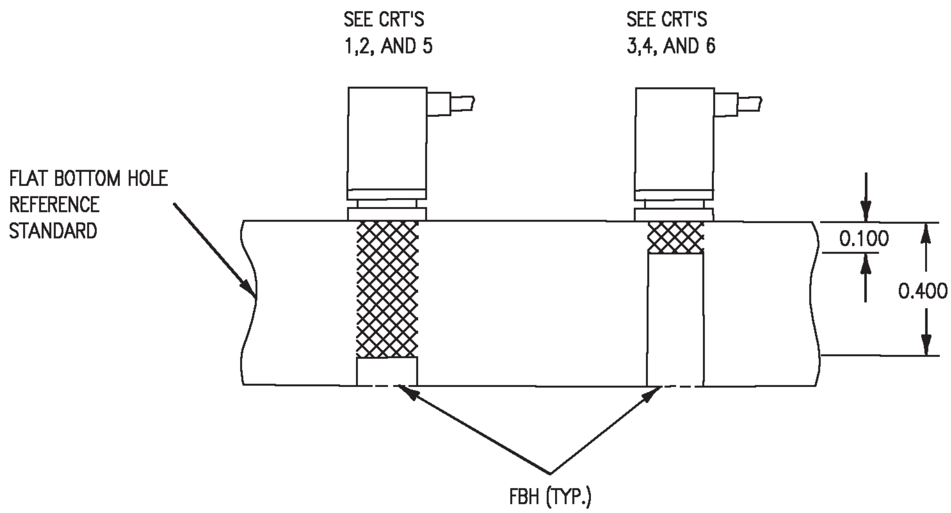
LEGEND

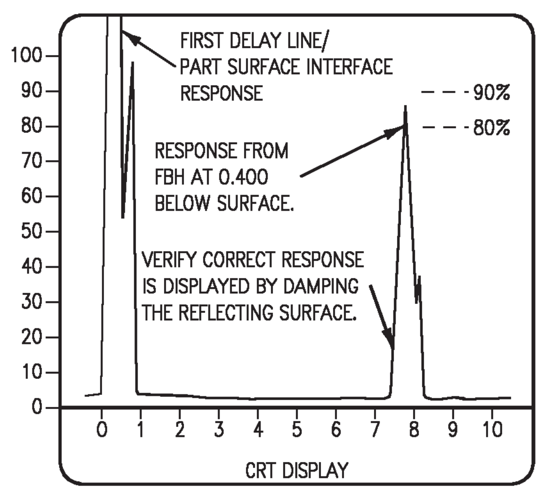


MULTIPLE MAY OR MAY NOT APPEAR

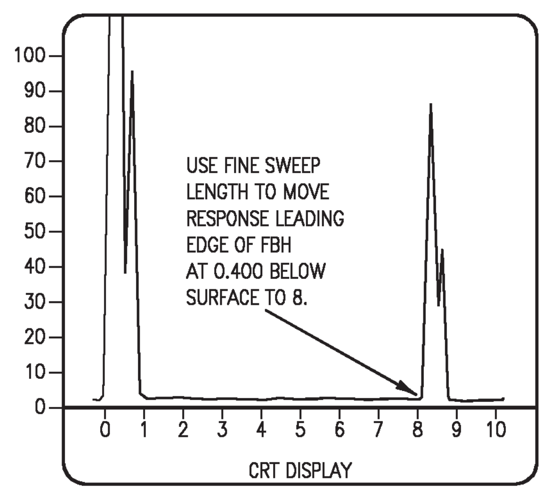
18AC-SRM-30-(422-2)31-SCAN

Figure 3. Composite Setup for 0.190 Inch Thick Composite Laminate Material Using Delay Line Search Unit (Sheet 2)





CRT 1



CRT 2

18AC-SRM-30-(423-1)31-SCAN

Figure 4. Composite Setup for 0.450 Inch Thick Laminate Material Using Delay Line Search Unit (Sheet 1)

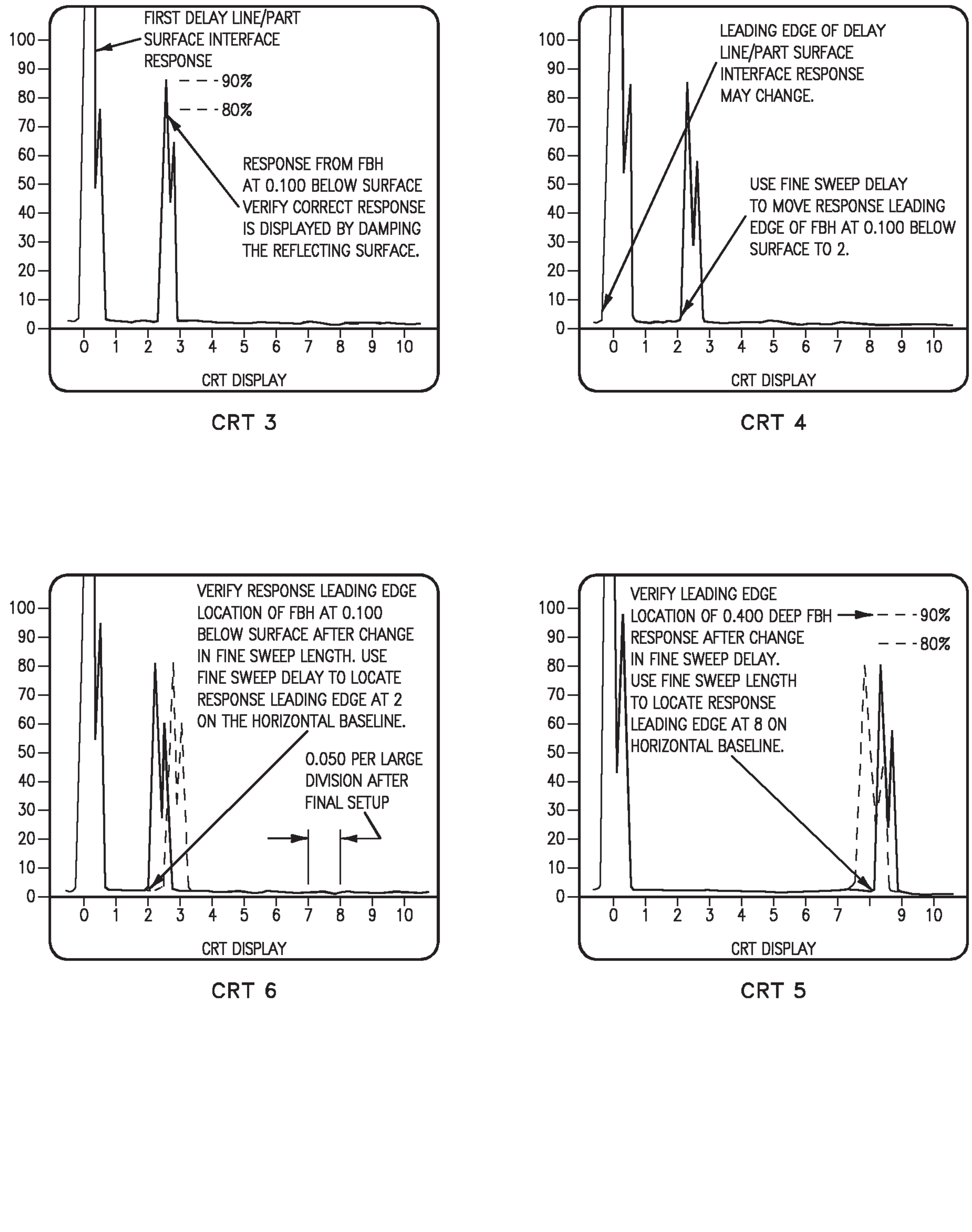


Figure 4. Composite Setup for 0.450 Inch Thick Laminate Material Using Delay Line Search Unit (Sheet 2)

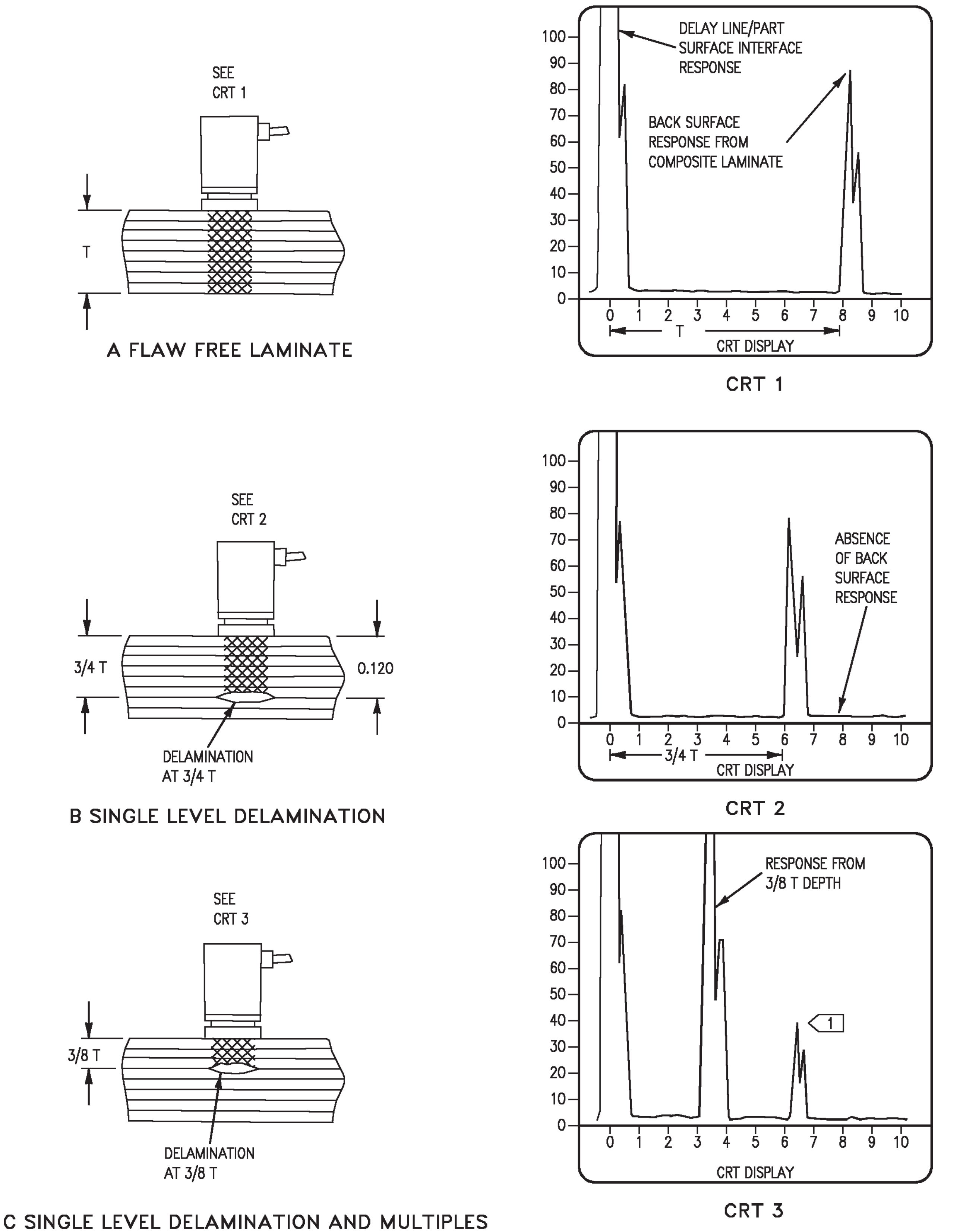
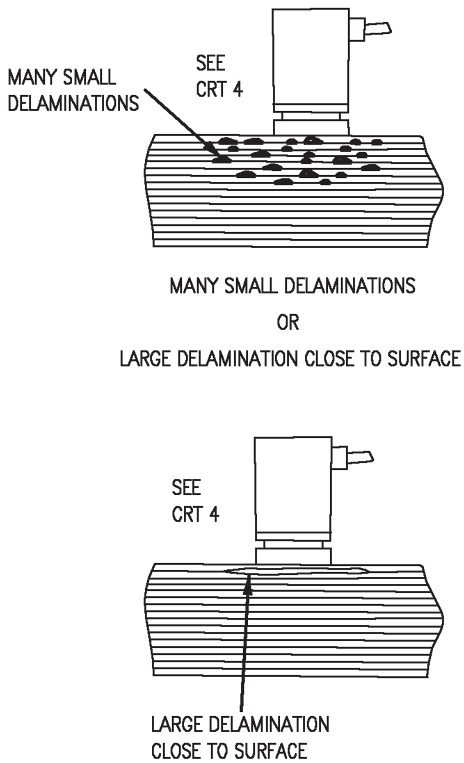
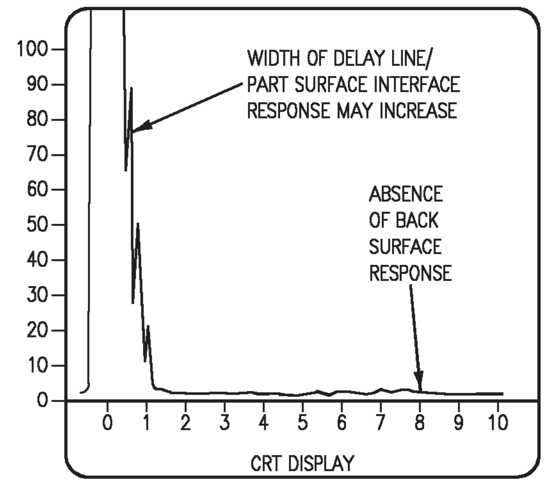


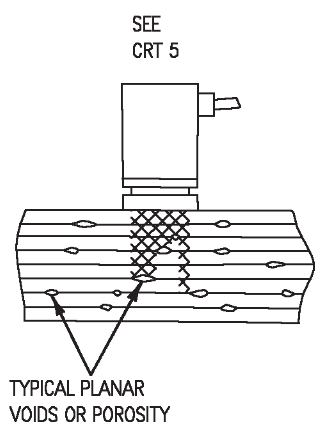
Figure 5. Typical Composite Laminate Inspection (Sheet 1)

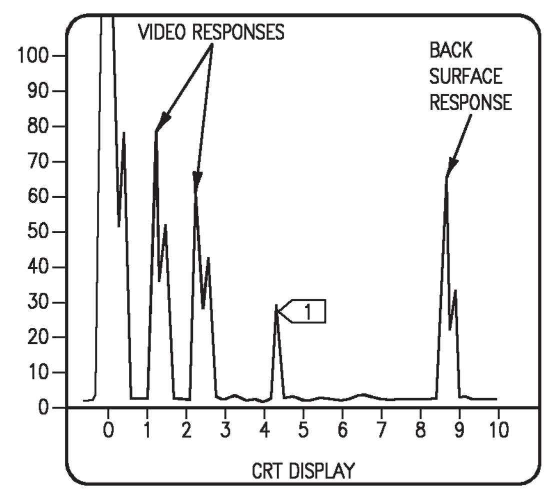




CRT 4

D SMALL DELAMINATIONS OR LARGE NEAR SURFACE DELAMINATION



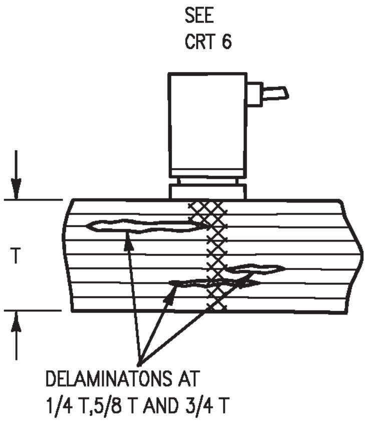


E PLANAR VOIDS OR POROSITY

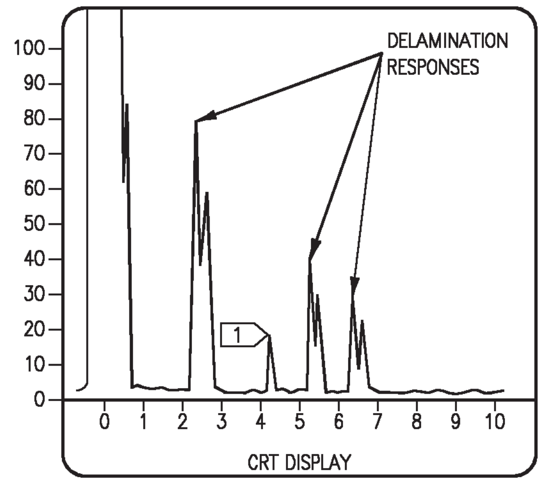
CRT 5

18AC-SRM-30-(424-2)31-SCAN

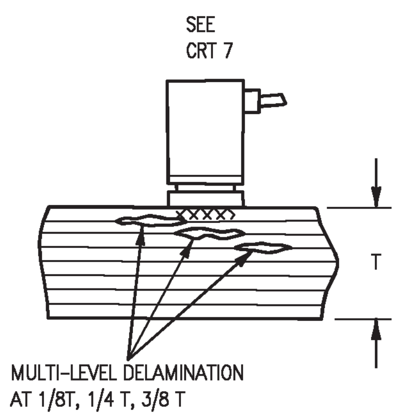
Figure 5. Typical Composite Laminate Inspection (Sheet 2)



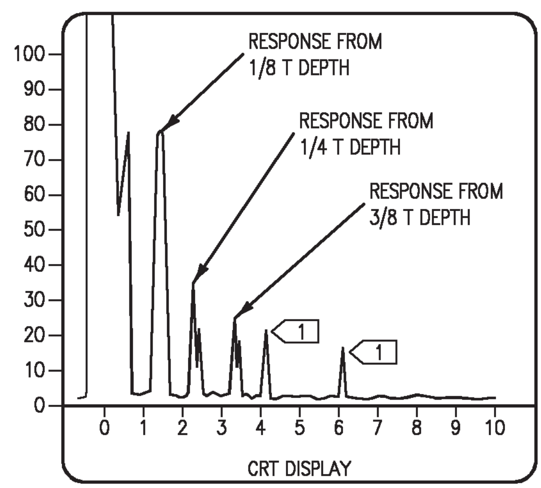
F MULTIPLE LEVEL DELAMINATION



CRT 6



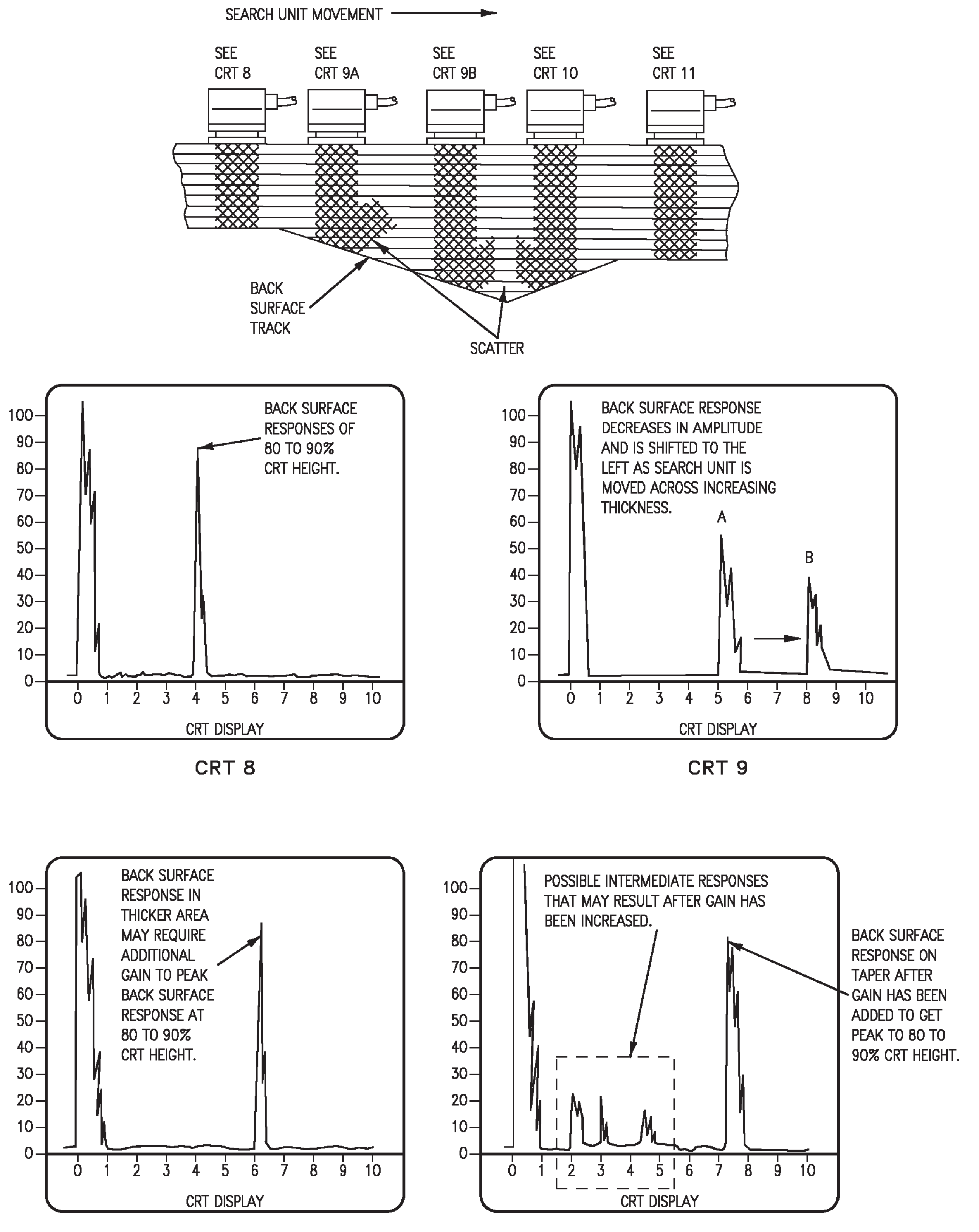
G MULTIPLE LEVEL DELAMINATION
AND MULTIPLES



CRT 7

18AC-SRM-30-(424-3)34-SCAN

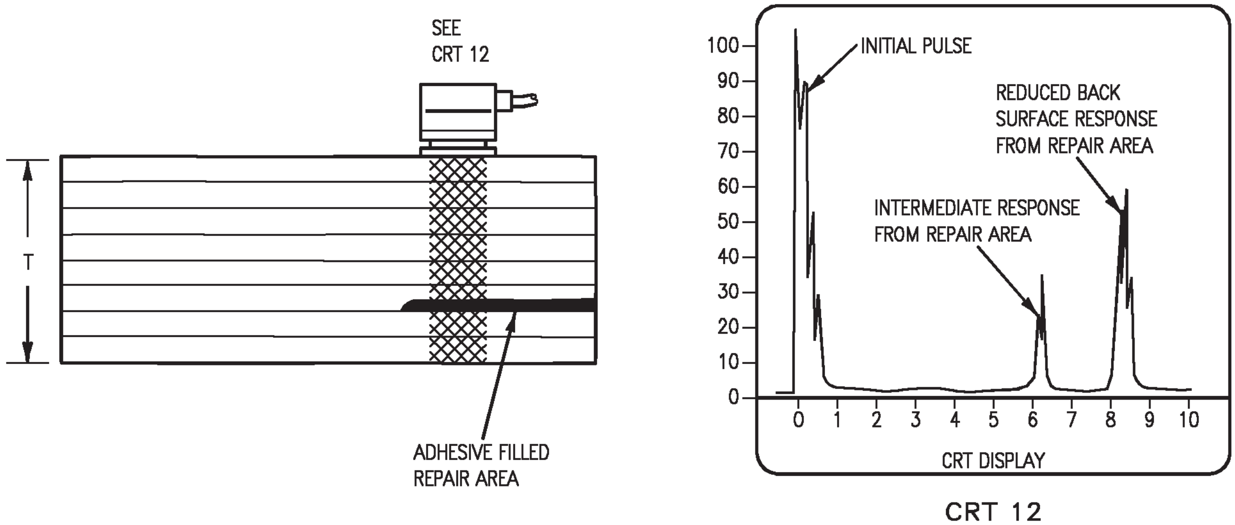
Figure 5. Typical Composite Laminate Inspection (Sheet 3)



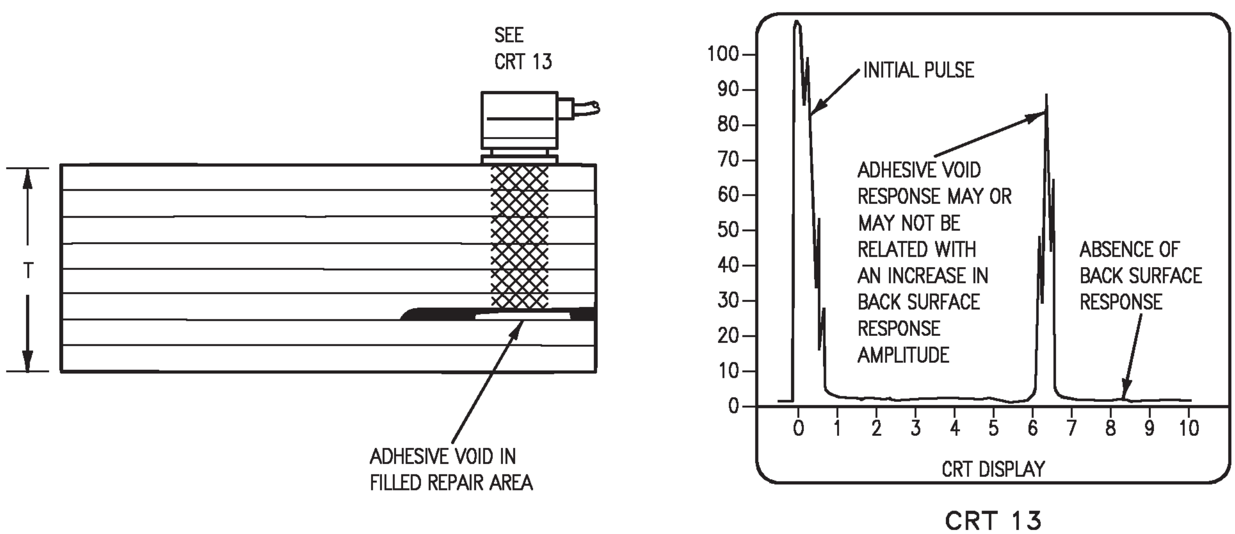
H SEARCH UNIT MOVEMENT ACROSS TAPER

18AC-SRM-30-(424-4)31-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 4)



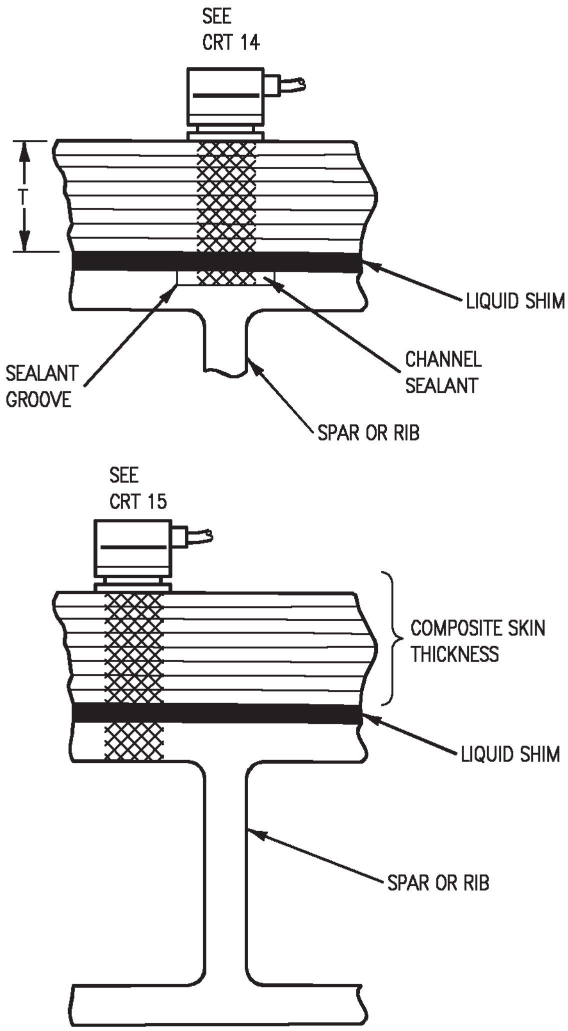
I ADHESIVE FILLED REPAIR AREA



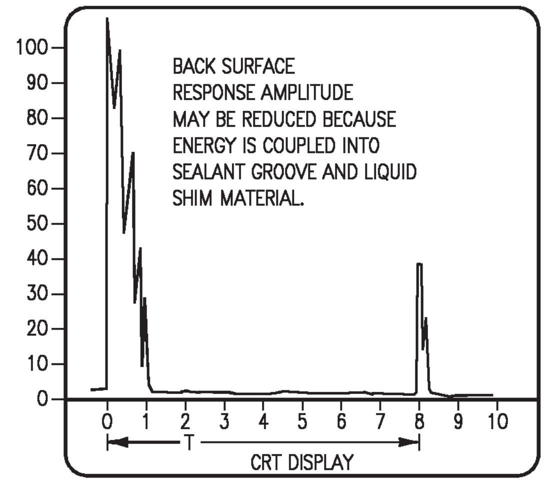
J ADHESIVE VOID IN FILLED REPAIR AREA

18AC-SRM-30-(424-5)31-SCAN

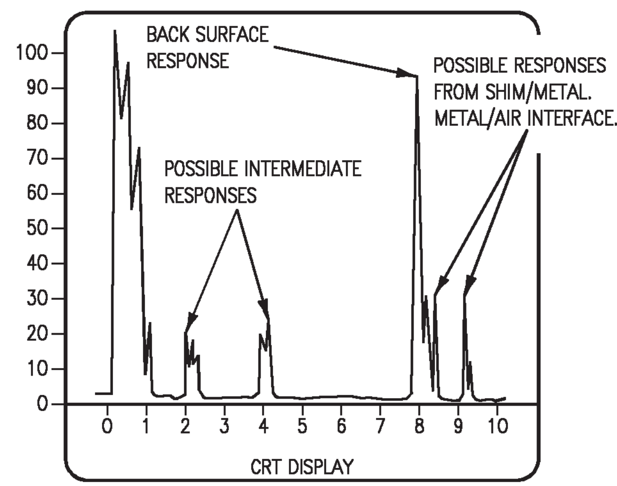
Figure 5. Typical Composite Laminate Inspection (Sheet 5)



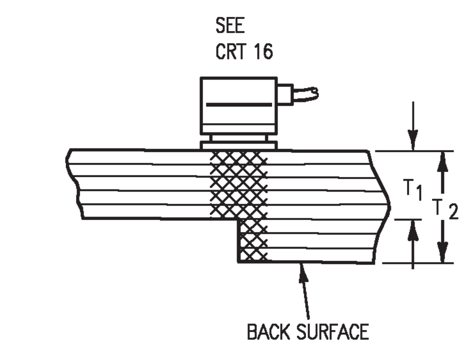
K AREA CONTAINING LIQUID SHIM



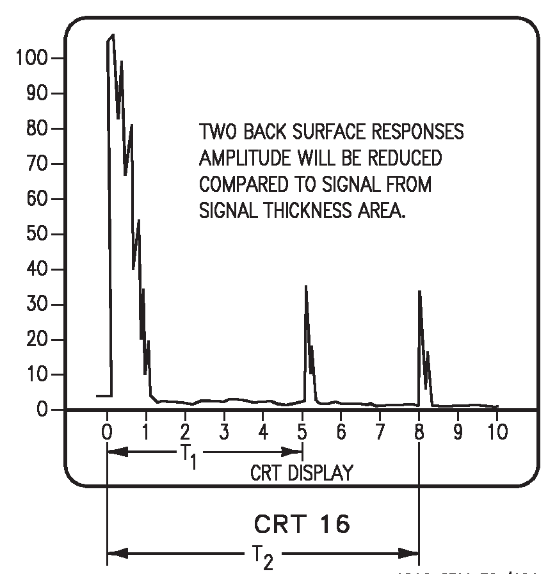
CRT 14



CRT 15



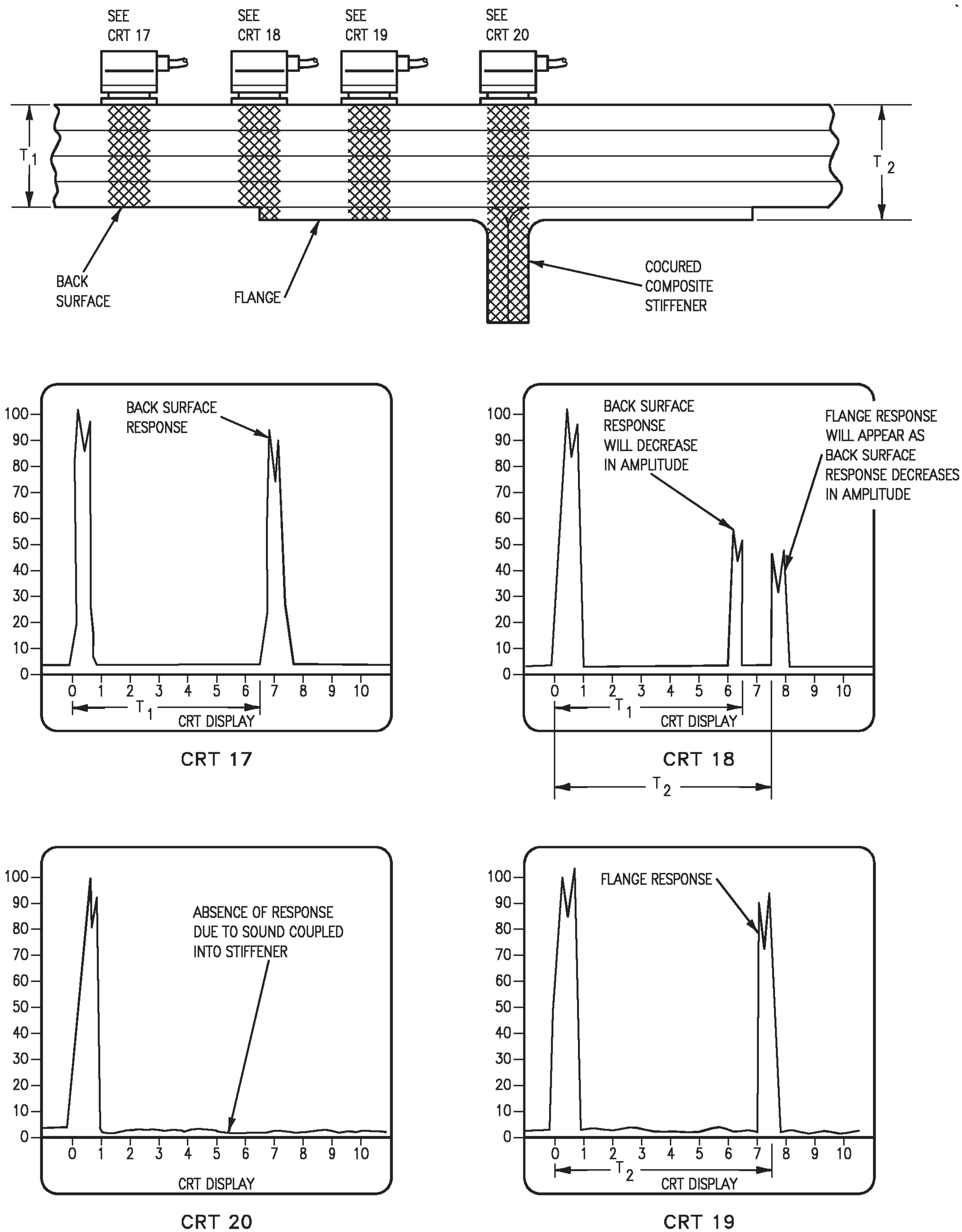
L THICKNESS CHANGE



CRT 16

1BAC-SRM-30-(424-6)31-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 6)



M COCURED COMPOSITE STIFFENER

18AC-SRM-30-(424-7)31-SCAN

Figure 5. Typical Composite Laminate Inspection (Sheet 7)

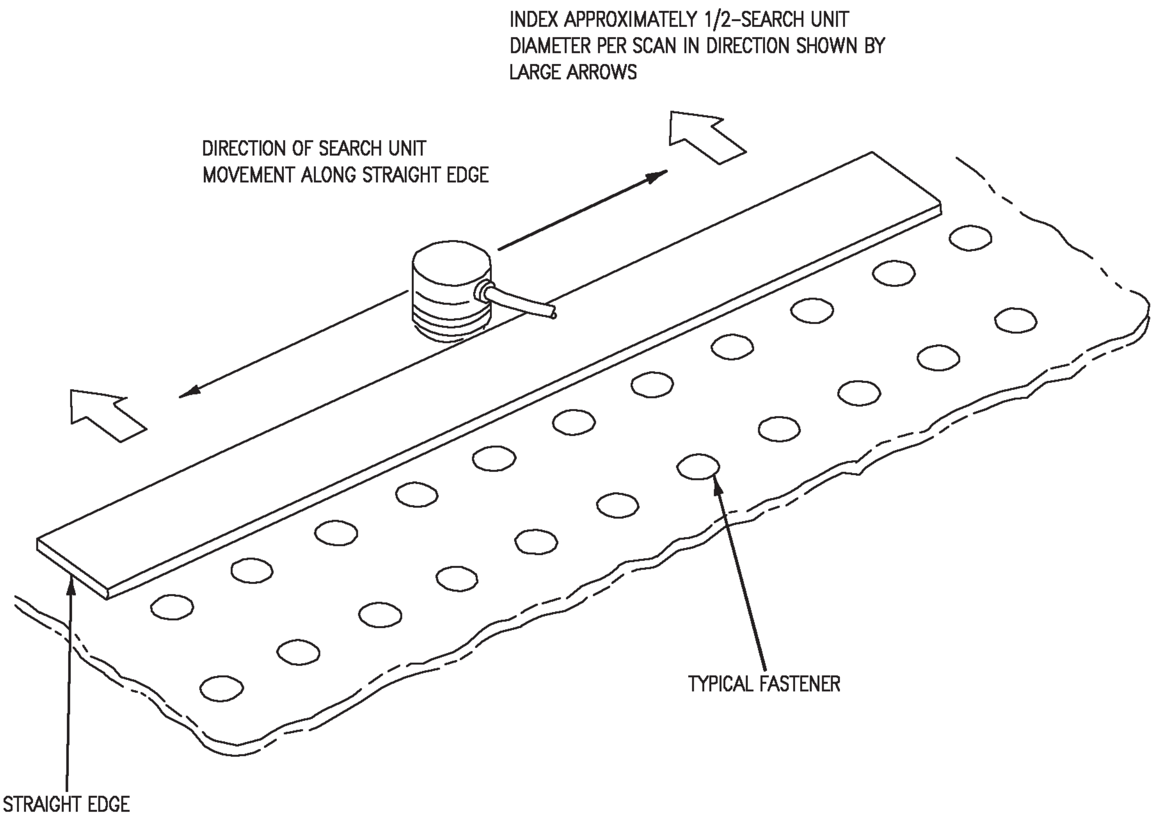


Figure 6. Scanning With Straight Edge Assist

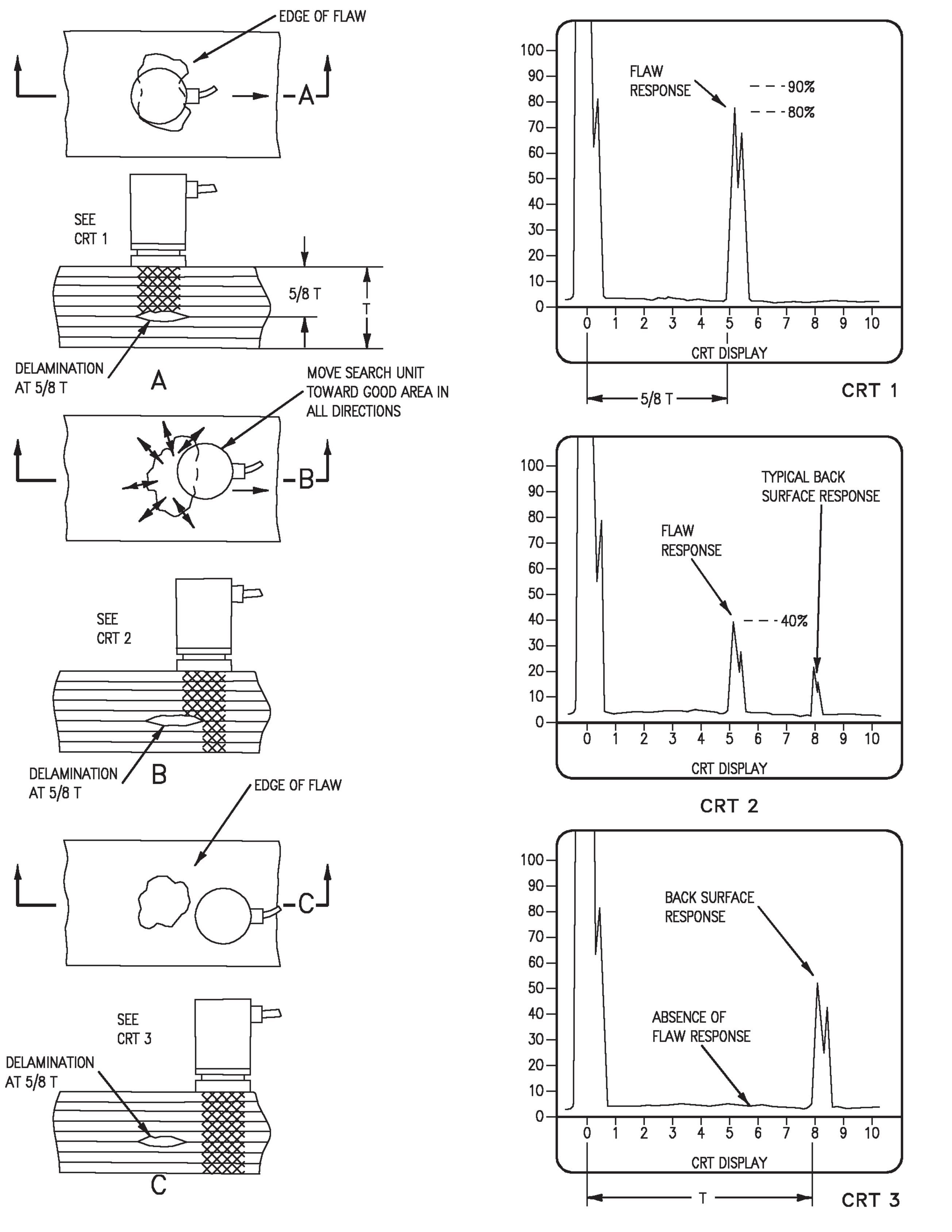


Figure 7. Half Amplitude Mapping Using Delay Line Search Unit Setup

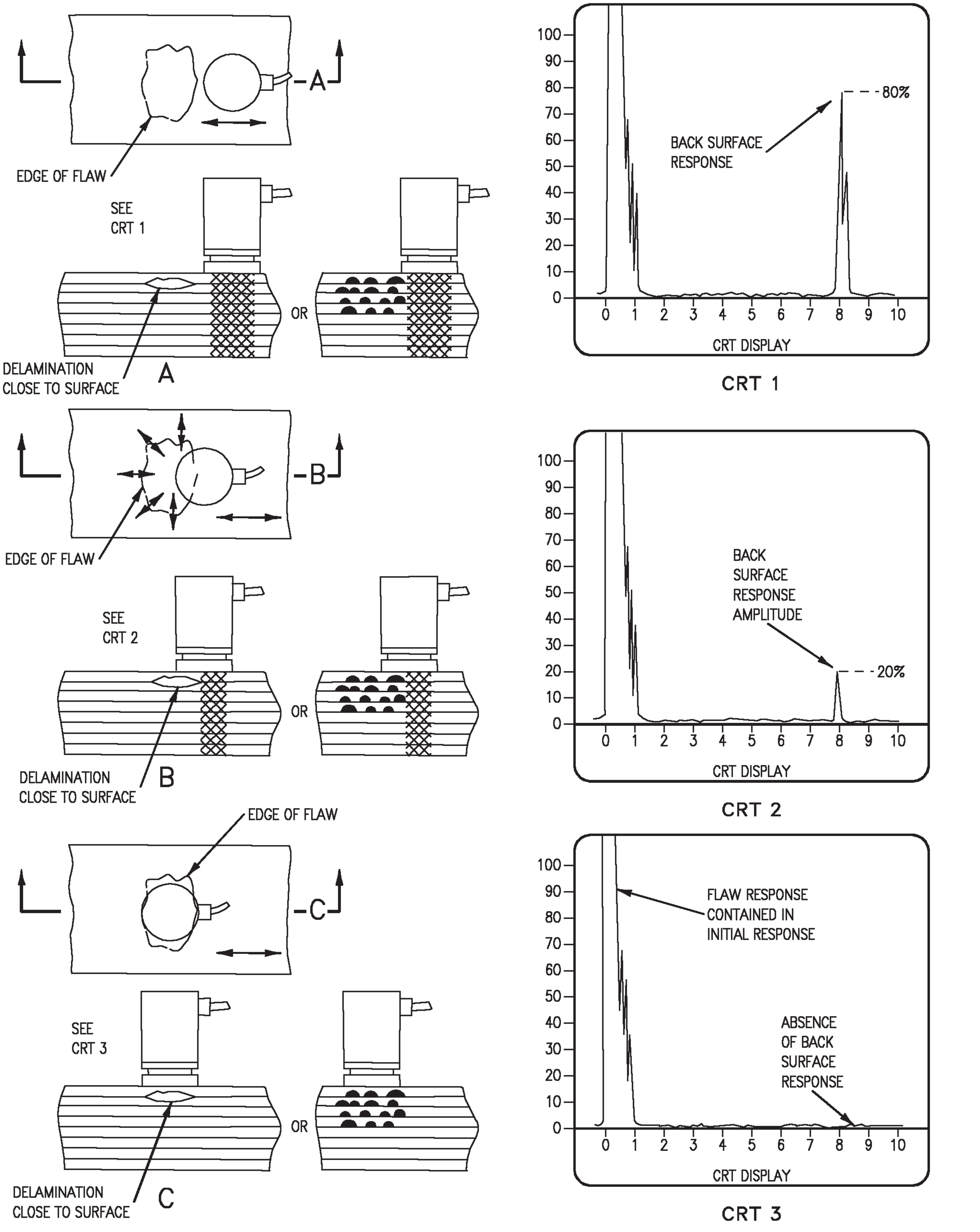


Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations

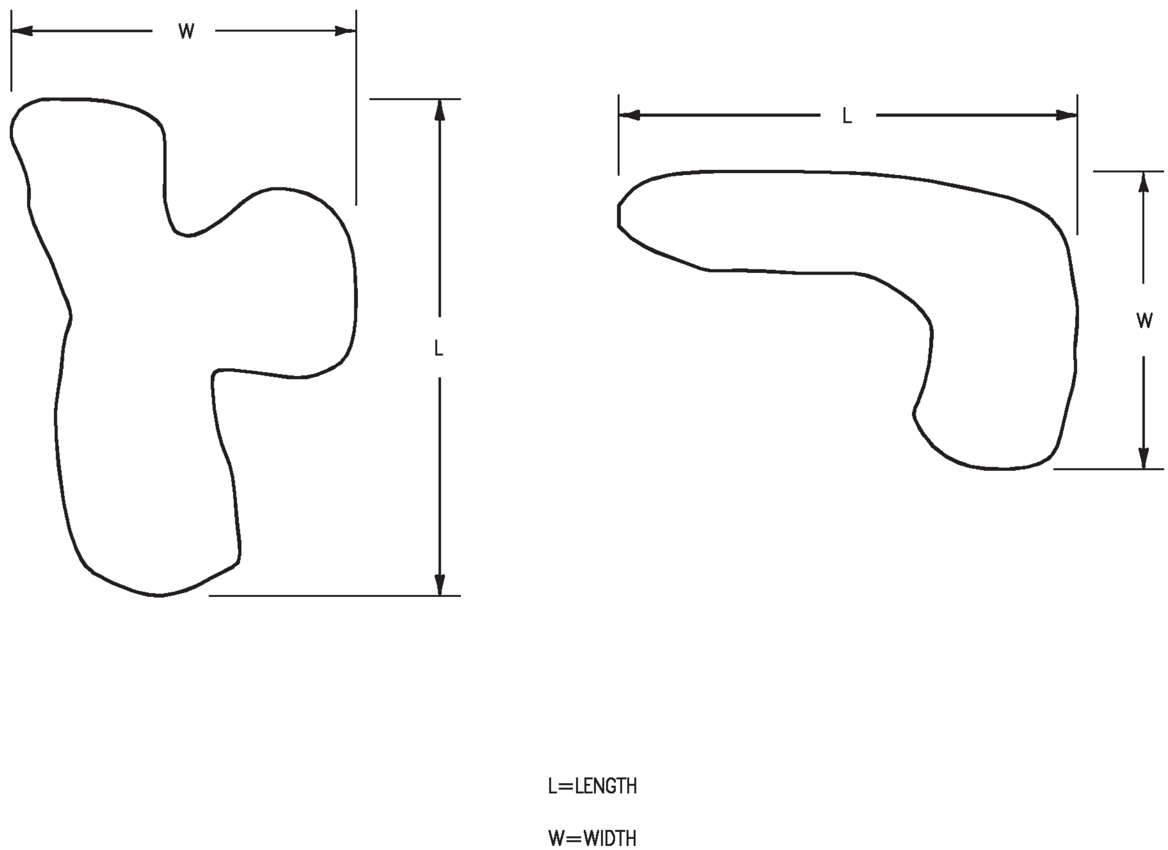


Figure 9. Half Amplitude Mapping

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE - ECHO LONGITUDINAL, CONTACT, WITH DELAY LINE, FOR COMPOSITE LAMINATE MATERIAL BONDED TO HONEYCOMB CORE

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulsed longitudinal waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is used to receive reflected ultrasonic waves. If there are no defects in part, ultrasonic waves will be reflected from back surface of part. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part are indicated by reduced travel time and/or reduction in amplitude of reflected ultrasonic wave. Delay line is used as standoff and often improves near surface resolution.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **PERSONNEL QUALIFICATIONS.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections

per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact Delay Line Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.950 Inch
74D111295-1005	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies Less Than 1 Inch
74D111295-1003	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 1 to 2 Inches
74D111295-1001	Honeycomb Reference Standard with Graphite Epoxy Skins for Sandwich Assemblies 2 Inches or Taller

Materials Required

Specification or Part Number	Nomenclature
ULTRAGEL II OR EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
020X413	Cleaning Compound
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

5. **EQUIPMENT SETTINGS/STANDARDIZATION/SETUP, GENERAL.**

a. Connect search unit to Microdot cable.

b. Connect BNC end of microdot cable to T or R BNC jacks on tester.

c. Turn tester ON. Allow 5 minutes warm-up.

d. Set tester front face settings:

NOTE

Tester settings listed are initial setup guide. Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	5

FINE........................	9.0
HORIZONTAL SWEEP LENGTH	
COURSE................	1
FINE........................	7.0
POLARITY....................	OFF
DISTANCE ECHO CORRECTION..........	OFF

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

e. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. First response from delay line/air interface may also be visible.

g. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline.

NOTE

During damping, amplitude of delay line/air interface response should decrease, but initial pulse amplitude should remain constant.

h. Adjust HORIZONTAL SWEEP FINE LENGTH and DELAY, and GAIN so first delay line/air interface response is visible on CRT horizontal baseline while initial pulse is still visible. Damp end of delay line with finger to get reduction in peak amplitude, and verify correct response is being viewed. See figure 1, CRT 2.

i. After delay line/air interface response has been identified, use HORIZONTAL SWEEP DELAY to locate this response at zero on CRT horizontal baseline. See figure 1, CRT 3.

NOTE

If second delay line/air interface response is not visible, increase GAIN to see if response appears. If increasing GAIN causes second response to appear, first damp transducer with finger to verify response is second delay line/air interface response and is not noise due to increased gain. Next, adjust HORIZONTAL SWEEP LENGTH to locate second delay line/air response off screen. Return GAIN to previous setting.

j. Second delay line/air interface response may be visible if certain settings have been selected. See figure 1, CRT 3. Second response may be moved off CRT or located beyond 10 on CRT horizontal baseline by adjusting HORIZONTAL SWEEP LENGTH. It is desirable to work in time period between first and second delay line interface responses. See figure 1, CRT 4.

k. After making adjustments to move second delay line/air response off CRT screen, make sure first delay line/air interface response is still located at zero on CRT horizontal baseline. Adjust HORIZONTAL SWEEP DELAY to relocate response to zero if it is not. See figure 1, CRT 4. Tester is now ready for time-base standardization.

CAUTION

Do not use grease pencil or otherwise mark on face of CRT filter. Damage to components will occur.

6. **TIME-BASE STANDARDIZATION COMPOSITE LAMINATES UP TO 0.190 INCH THICK.** Time base standardization is required because delamination in composite materials are detected ultrasonically as thickness changes. Following sequence calibrates horizontal time base of tester in units of laminate material per CRT horizontal baseline division. CRT

horizontal baseline contains 10 large divisions and 100 small divisions. When one large division has been setup to represent 0.020 of material, unknown response located at 5 large divisions on CRT horizontal baseline represents 0.100 of setup material. Full scale response at 10 on CRT horizontal baseline would be equivalent to 0.200 of composite material after setup. Use flat bottom hole (FBH) graphite epoxy reference standard, 74D111295-1009, which is part of the 74D110175-1001 reference standard set to complete following standardization.

a. Begin with equipment settings as described in paragraph 5.d. First delay line/air interface response should be located at zero on CRT horizontal baseline. See figure 1, CRT 4.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

FBH represents flat bottom hole. Reference standard of Figure 2 has FBHs machined into bulk material to make known depths or thicknesses of material. In steps that follow, number before FBH represents material thickness/depth, inches, above flat bottom hole.

b. Apply couplant to upper surface of reference standard, 74D111295-1009, which is part of the 74D110175-1001 reference standard set, over 0.100 FBH.

c. Position search unit over 0.100 FBH.

d. Adjust GAIN so peak amplitude of first back surface response from 0.100 FBH is 80 to 90 percent CRT height. See figure 3, CRT 1.

NOTE

Assuming there are no flaws between front surface of test standard and bottom, or reflecting surface, of FBH, damping should cause change in response signal on CRT. Change in response signal during damping indicates correct response is being received and displayed on CRT.

e. Damp bottom, or reflecting surface, of 0.100 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response.

NOTE

Minimum REJECT is recommended.

f. Use DAMP, REJECT, and VIDEO DISPLAY FILTER to optimize response and remove baseline noise. Remove couplant from reflecting surface before continuing.

g. With response peak located at 80 to 90 percent CRT height, use HORIZONTAL SWEEP FINE LENGTH to locate leading edge of 0.100 FBH response at 5 on CRT horizontal baseline. See figure 3, CRT 2.

h. Apply couplant to upper surface of reference standard over 0.040 FBH.

i. Position search unit over 0.040 FBH.

j. Adjust GAIN, probably decrease, so peak amplitude of first back surface response from 0.040 FBH is 80 to 90 percent CRT height. See figure 3, CRT 3. Response multiples may or may not be visible.

k. Damp bottom, or reflecting surface, of 0.040 FBH to make sure correct response is being received and displayed on CRT. Use finger or cotton swab and couplant to damp response. Remove couplant from reflecting surface before continuing.

l. With response peak located at 80 to 90 percent CRT height, use HORIZONTAL SWEEP FINE DELAY to locate leading edge of 0.040 FBH response at 2 on CRT horizontal baseline. See figure 3, CRT 4.

m. Reposition search unit over 0.100 FBH and adjust GAIN, probably increase, so response peak amplitude is 80 to 90 percent CRT height. Verify horizontal baseline position of 0.100 FBH response is still located at 5 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE LENGTH to relocate leading edge of 0.100 FBH response at 5 when response peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 5.

n. After any changes in HORIZONTAL SWEEP FINE LENGTH, reposition search unit over 0.040 FBH and adjust GAIN, probably decrease, so 0.040 FBH peak amplitude is 80 to 90 percent CRT height. Verify response leading edge is still located at 2 on CRT horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use HORIZONTAL SWEEP FINE DELAY to relocate 0.040 FBH response leading edge at 2 on CRT horizontal baseline when response peak amplitude is 80 to 90 percent CRT height.

o. Repeat steps m. and n. as many times as required. Verify correct leading edge locations of responses from 0.100 and 0.040 FBHs when peak amplitudes are 80 to 90 percent CRT height after any changes in either HORIZONTAL SWEEP FINE LENGTH or DELAY have been made.

NOTE

CRT horizontal baseline is now calibrated to measure composite laminate materials up to 0.190 in thickness. Each large division on CRT horizontal baseline represents 0.020 of material. See figure 3, CRT 6.

p. Test setup by positioning search unit over other FBHs whose location and depth is accurately known. FBH response leading edge location should be as follows when GAIN is adjusted so peak amplitude is 80 to 90 percent CRT height:

$$\text{CRT Large Division Location} = \frac{\text{FBH Depth (Inches)}}{\text{0.020 Inch per Large Division}}$$

q. Determine depth of unknown response as follows:

$$\text{Unknown Response Depth (inches)} = \text{CRT Large Division Location} \times \text{0.020 inch per CRT Division}$$

NOTE

Assemblies with thinner laminates, repeat steps n. and o. using reflecting surfaces from 0.015 or 0.025 and 0.075 deep FBHs. With thinner materials and expanded baseline, new set of horizontal sweep length and delay control settings will be required. Composite material thickness per graticule division will have to be calculated after settings have been established.

r. Tester is now standardized for inspection of composite laminates up to 0.190 thick.

7. INSPECTION PROCEDURE.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Thicknesses given in specific work packages are nominal thicknesses only. Actual part thicknesses can vary ±5 percent. Use given thicknesses as values to determine nominal position of back surface response on CRT.

b. Before beginning inspection, determine locations of ply changes, particularly rapid ply changes, stiffeners, and other items lying beneath surface of inspection area(s). This information should be described in specific procedure work packages. Lay out locations of ply changes, stiffeners, and other sub-surface features on part surface with aircraft marking pencil or mylar

overlay. Also include applicable thicknesses of part of areas of part on overlay.

c. To make sure large parts are completely inspected, mark grid pattern(s) on inspection area per specific work package using aircraft marking pencil and straight edge. See figure 5. If grid pattern is not indicated in specific work package, mark 6.0 X 6.0 grid on inspection surface.

d. Complete setup and standardization procedures in paragraphs 5 and 6 for composite thickness of part being inspected.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area.

f. Position search unit on laminate at location where approximate thickness is known or has been measured mechanically. Search unit wear face should be parallel to back surface of laminate. See figure 4, CRT 1.

g. Adjust GAIN so leading edge of back surface response is 80 to 90 percent CRT height. See figure 4, CRT 1.

h. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, use 1/2 search unit diameter. Use straight edge to help in alignment and correct indexing of search unit, as shown in figure 5. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, rabbets, or edge. Where thickness changes occur at angle with respect to stiffeners, rabbets, or edge, scan parallel to these areas. Scan at rate no greater than 1 to 2 feet per minute. Scan entire area within one grid block before inspecting next grid.

i. Mark all areas where back surface response disappears or is shifted toward initial pulse. Use guidelines given in paragraphs 8 through 12 on CRT interpretation to identify flaws. Make sure of coupling before marking defect. Typical delamination or flaw response characteristics from defects at 1/2-laminate thickness are shown in figure 6.

j. Once flaw has been identified, use pulse-echo mapping technique shown in figure 7 and described in paragraph 13.a. for 1/2-amplitude mapping, and figure 8, paragraph 13. b. for mapping flaws close to surface or small multiple delaminations to determine defect edges. Defect depth may be measured by determining CRT horizontal baseline location of response leading edge.

k. Mark all flaw indications on part surface with aircraft marking pencil.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape because of instrument and transducer differences.

8. **CRT INTERPRETATION.** For area free of flaws or structural features that alter response, only initial pulse, and possibly back surface response should be visible on CRT. Back surface response should be located at CRT horizontal baseline location that corresponds to thickness of inspection area. See figure 4, CRT 1. Thickness corresponding to each CRT horizontal baseline division depends on time base standardization that was completed inspection, described in paragraph 6.

9. **Single Level Delamination.** Delamination will be indicated by new response shifted toward initial pulse and complete loss of back surface response. See figure 4, CRTs 2 and 3. For delaminations located at some depths, multiple of delamination response may appear. See figure 4, CRT 3.

10. **Small Delaminations and Large Near Surface Delaminations.** Small delaminations throughout part, or one large, near-surface delamination will both be indicated by absence of back surface response with no intermediate responses. See figure 4, CRT 4.

NOTE

If it is not clear whether indication is due to near surface delamination or presence of heavy porosity, and back Surface of part is accessible, access back surface of part and do spot inspection on area in question using through transmission contact technique. No transmission indicates delamination is present. If small response is detected, it is likely that area contains heavy porosity.

11. **Planar Voids.** Presence of planar voids may be indicated by one or more intermediate responses and reduction in amplitude of back surface response. More than one intermediate responses may be due to presence of numerous planar voids and multiples from single planar voids. See figure 4, CRTs 5 and 6.

12. **Adhesive Separated From Back Surface of Laminate.** Increase in response amplitude may indicate that adhesive is separated from back surface of laminate skin. In good area, response from adhesive/air interface may be present to right of laminate/adhesive interface response. If adhesive is unbonded from laminate, this adhesive/air interface response will be absent. See figure 4, CRTS 7 and 8.

13. **MAPPING.**

a. Half amplitude mapping:

(1) Locate preliminary outline of flaw.

(2) Position search unit over flaw and increase GAIN so flaw response is 80 percent of CRT height. See figure 7, CRT 1.

(3) Move search unit toward good area in all directions. Use aircraft marking pencil to mark surface of part under center of search unit when flaw response reaches 1/2 amplitude. See figure 7, CRT's 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

b. Amplitude Mapping For Flaws Close to Surface or Small Multiple Delaminations:

(1) Locate preliminary outline of flaw.

(2) Position search unit over good area and increase GAIN so back surface response is 80 percent of CRT height. See figure 8, CRT 1.

(3) Move search unit toward flaw in all directions. Use aircraft marking pencil, mark surface of part at center of search unit when back surface response reaches 20 percent CRT height. See figure 8, CRT's 2 and 3.

(4) Determine defect(s) size and depth. Mark defect(s) on surface of part using aircraft marking pencil.

NOTE

When unbond has irregular shape, draw smooth curve around unbond to determine length and width as shown in figure 9.

14. **ACCEPTANCE CRITERIA.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap zones/areas on part. Horizontal baseline location of response leading edge or by using delay line technique when defect is close to surface.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

15. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to dry for 15 minutes after cleaning.

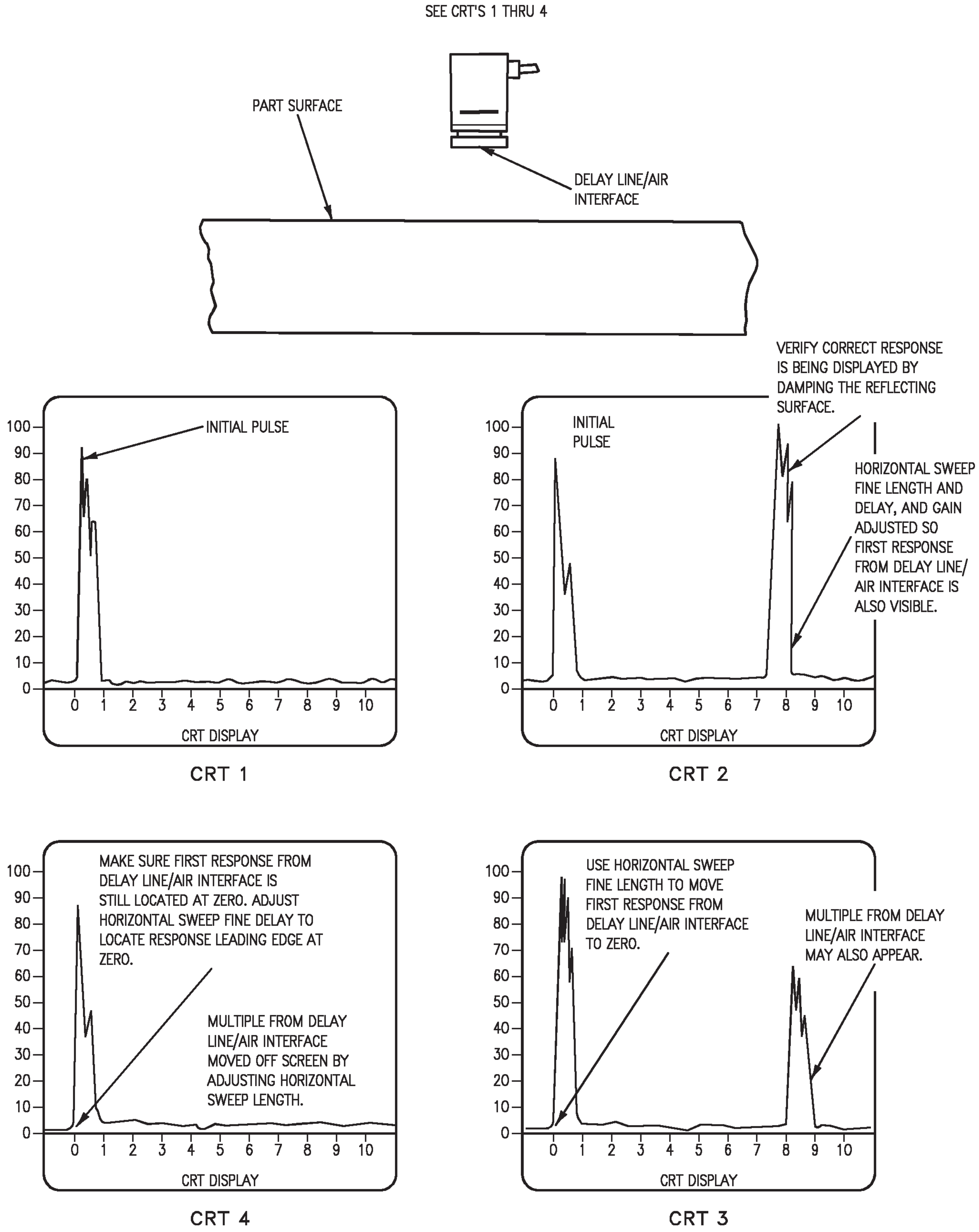
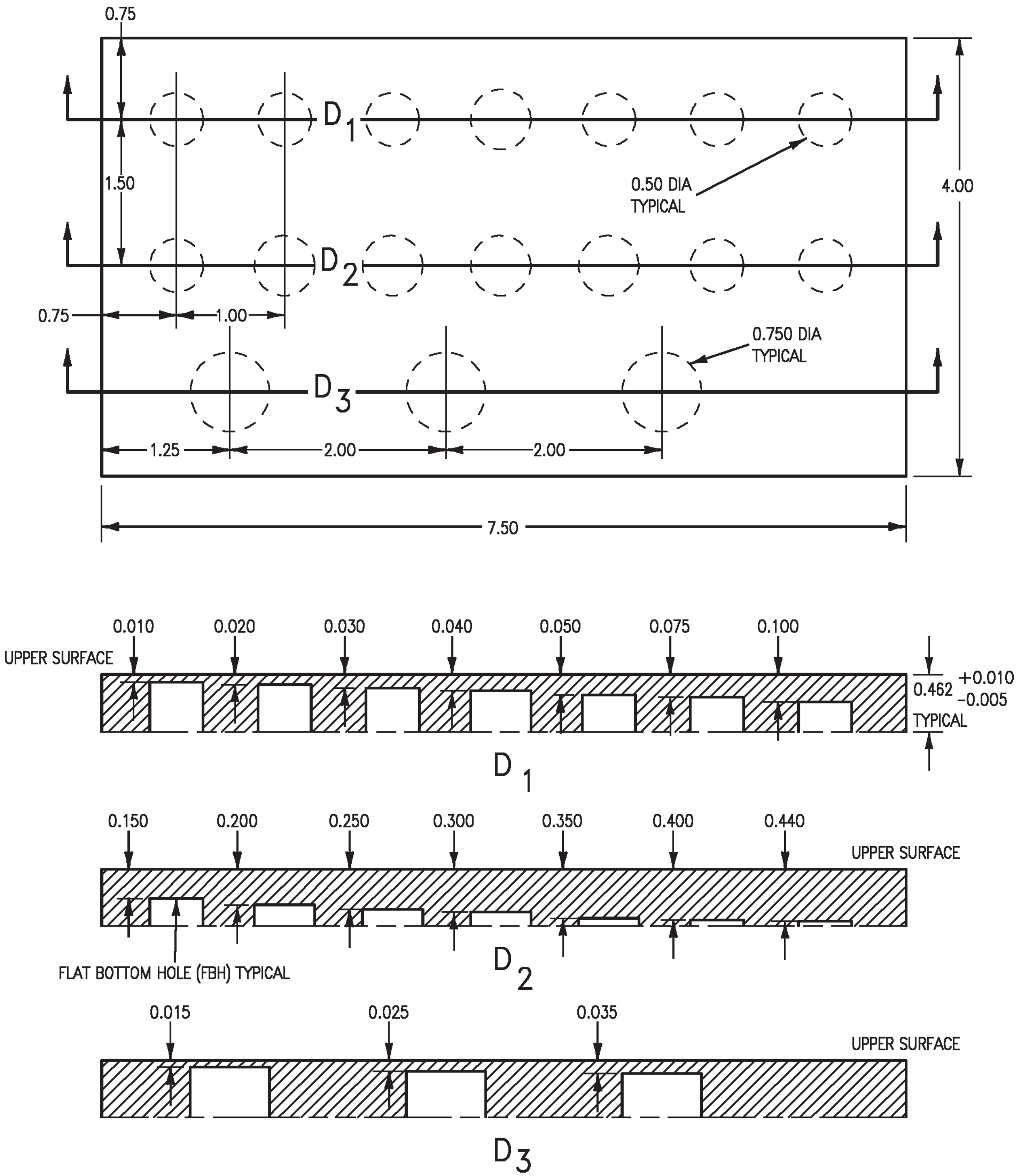


Figure 1. Initial Setup 0.190 Inch Composite Laminate Material With Delay Line Search Unit



74D111295-1009

GRAPHITE EPOXY LAMINATE

FLAT BOTTOM HOLE ULTRASONIC REFERENCE
STANDARD FOR LAMINATES TO 0.450 INCH.

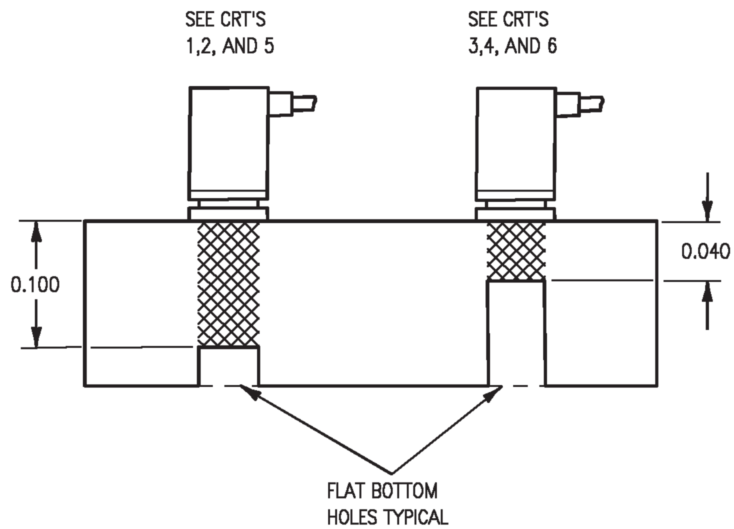
LEGEND

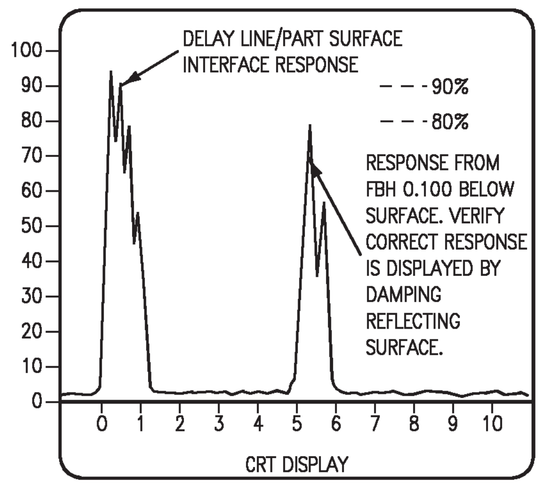
D_1, D_2 AND D_3 = DEPTH

DEPTH = MEASURMENT FROM TOP SURFACE
TO BOTTOM OF FLAT BOTTOM HOLE (FBH)

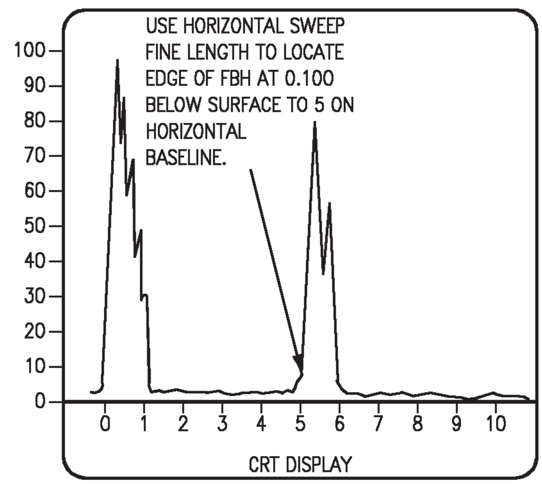
18AC-SRM-30-(430-1)32-CATI

Figure 2. FBH Reference Standard for Delay Line Setup





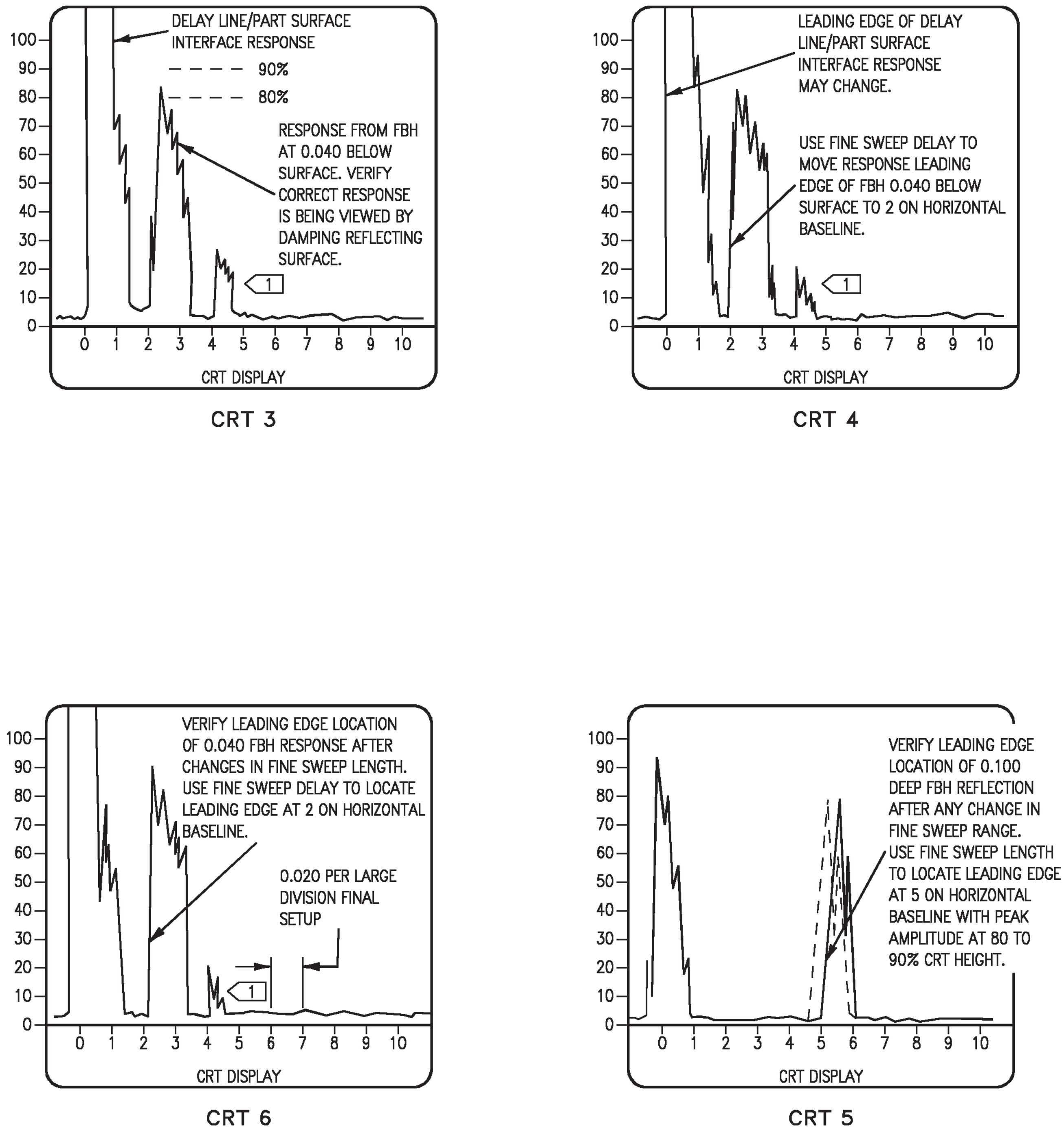
CRT 1



CRT 2

18AC-SRM-30-(431-1)32-SCAN

Figure 3. Composite Setup for 0.190 Composite Laminate Material Delay Line Search Unit (Sheet 1)



LEGEND

1 MULTIPLE MAY OR MAY NOT APPEAR.

18AC-SRM-30-(431-2)32-SCAN

Figure 3. Composite Setup for 0.190 Composite Laminate Material Delay Line Search Unit (Sheet 2)

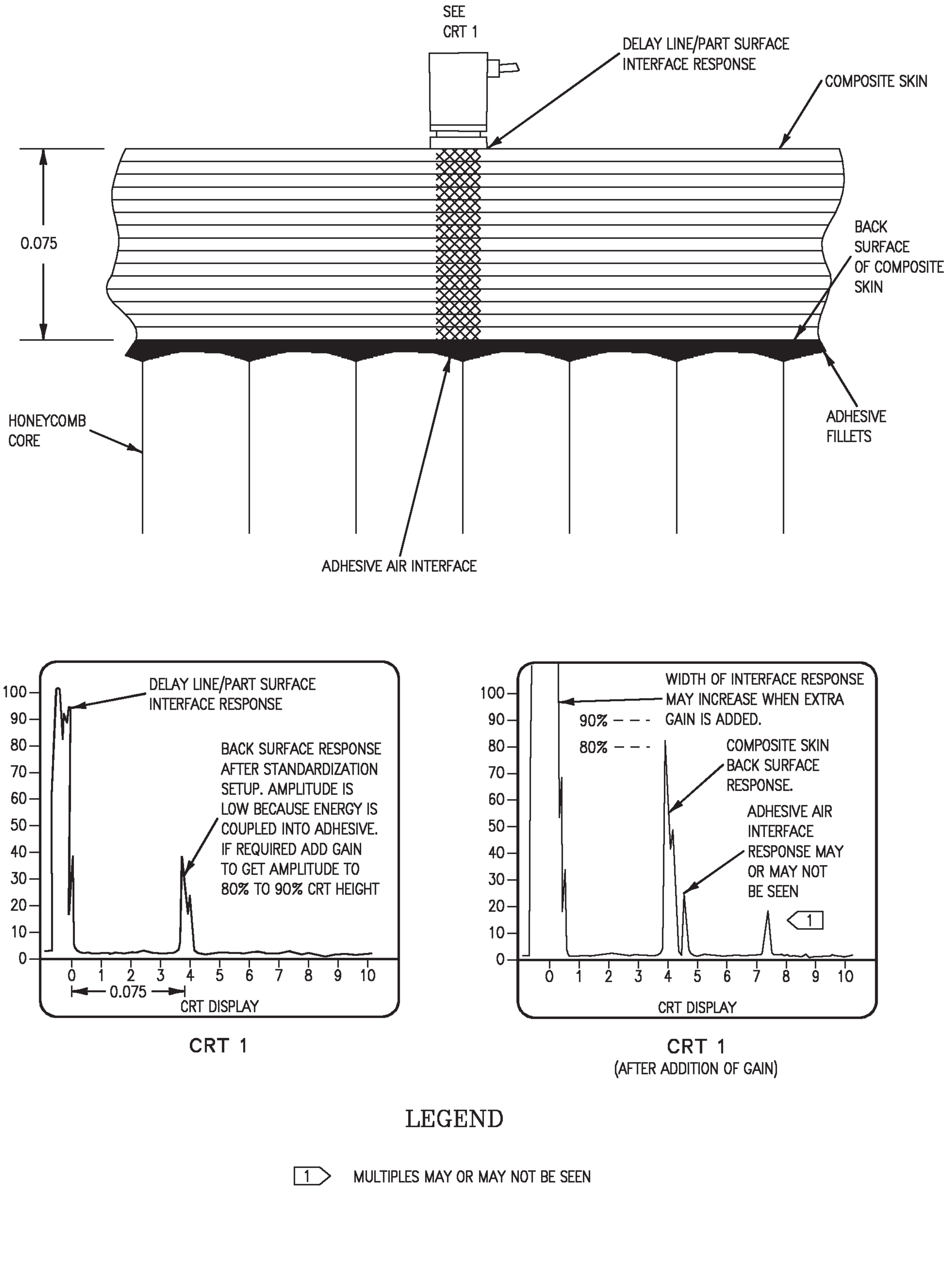
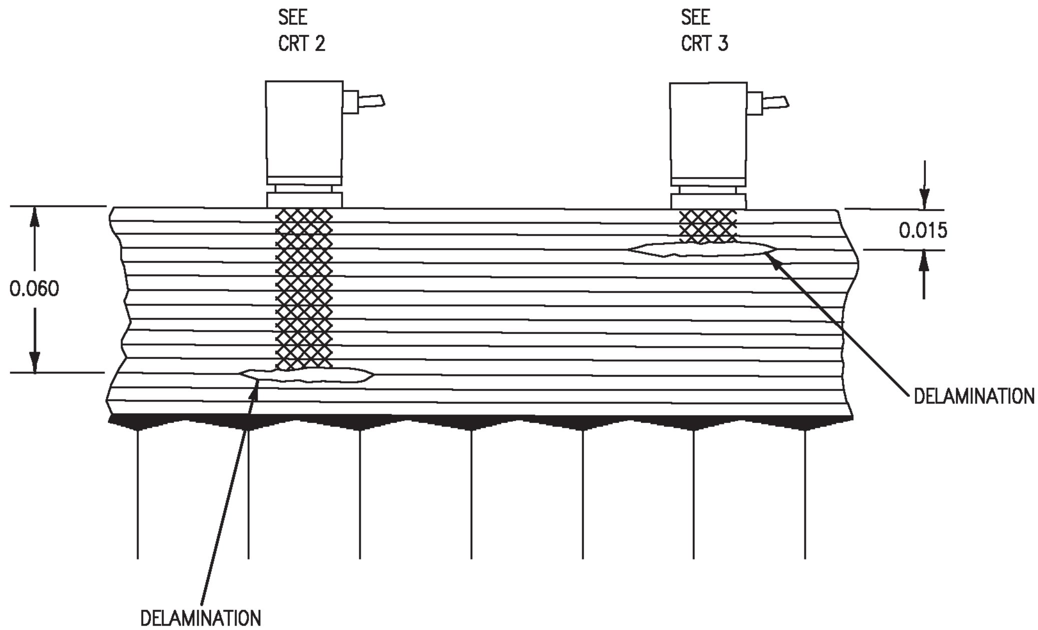


Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 1)



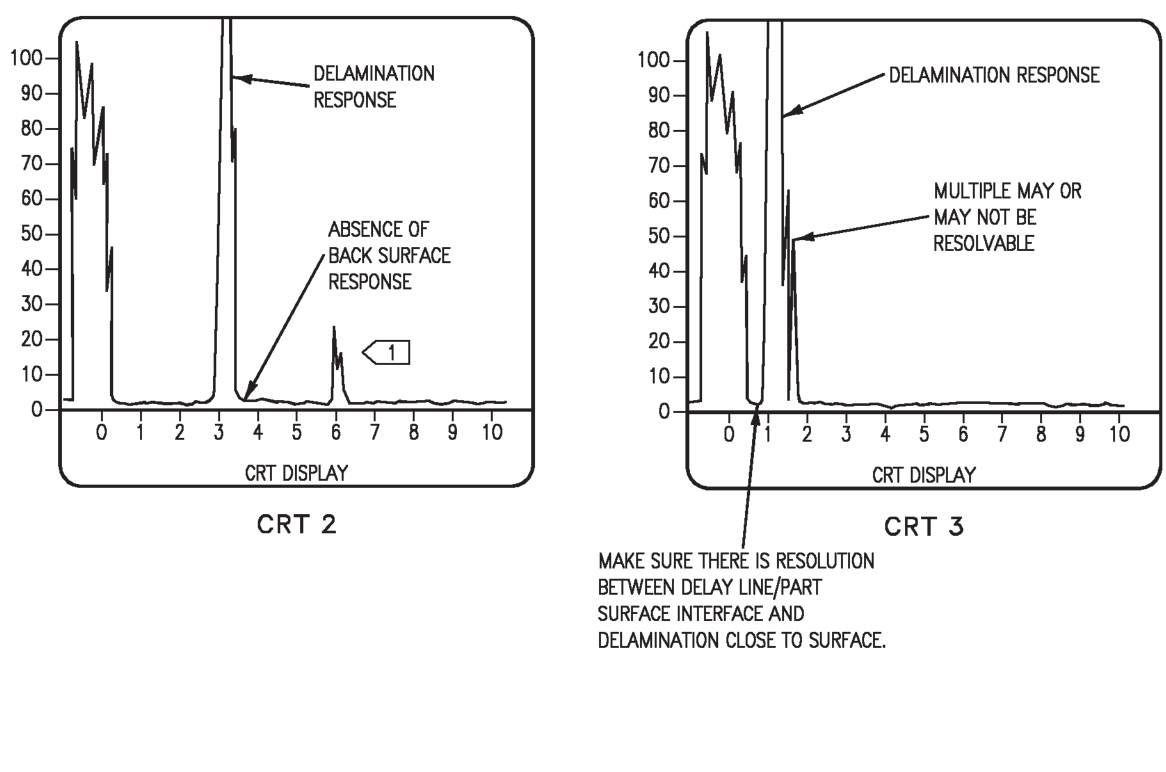
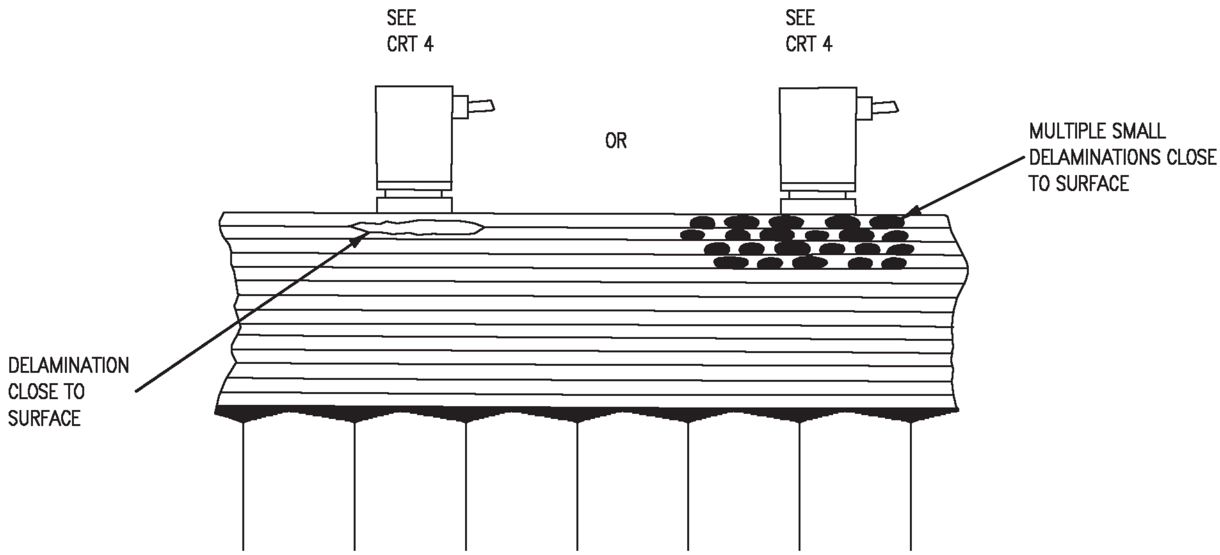
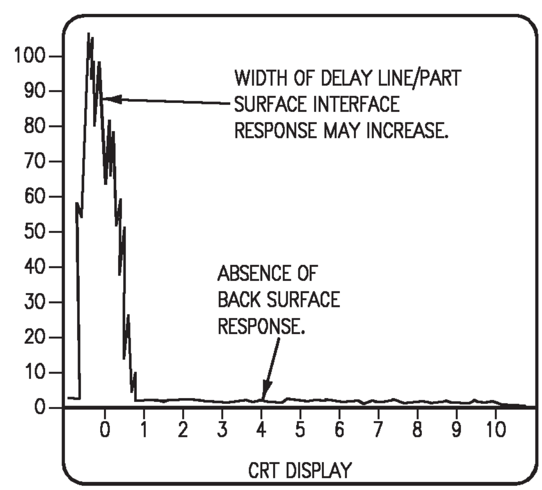


Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 2)

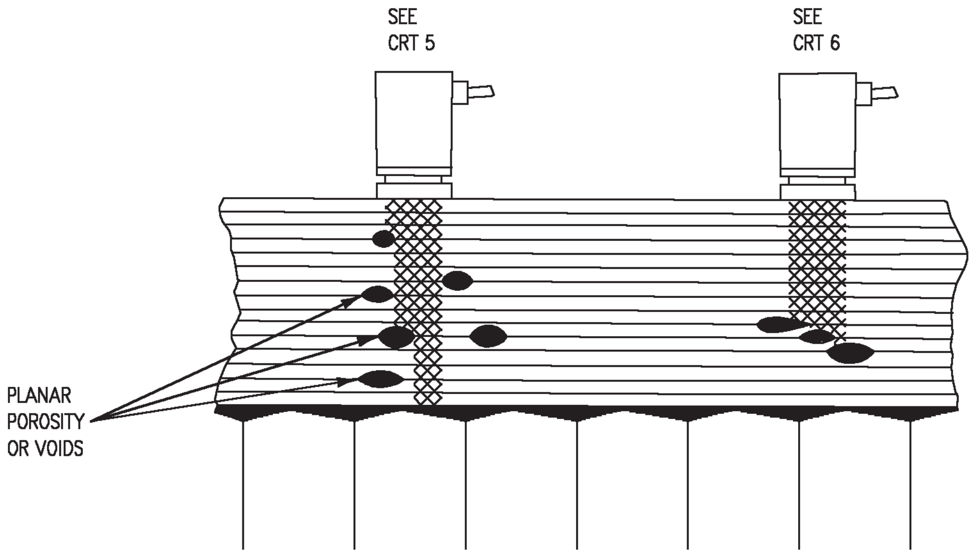


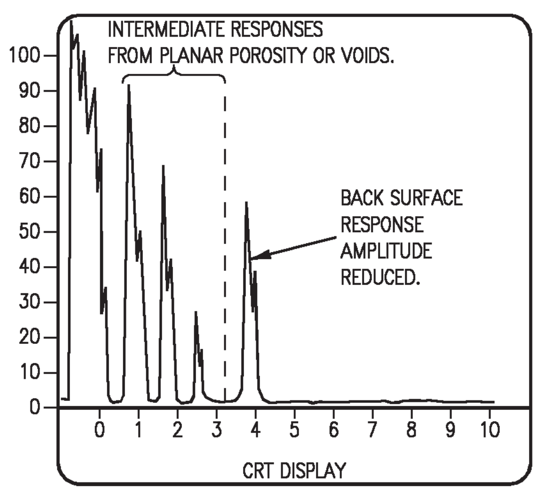


CRT 4

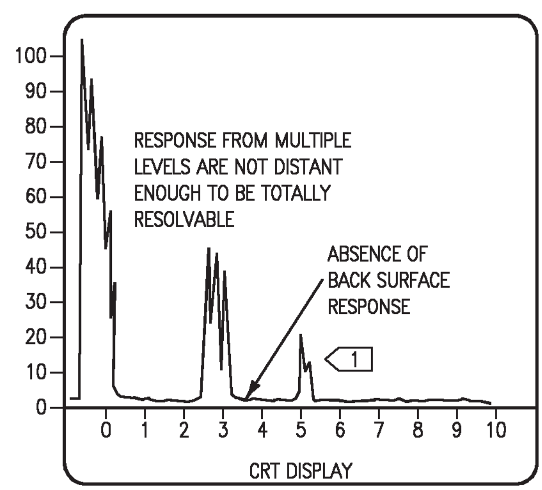
18AC-SRM-30-(432-3)32-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 3)





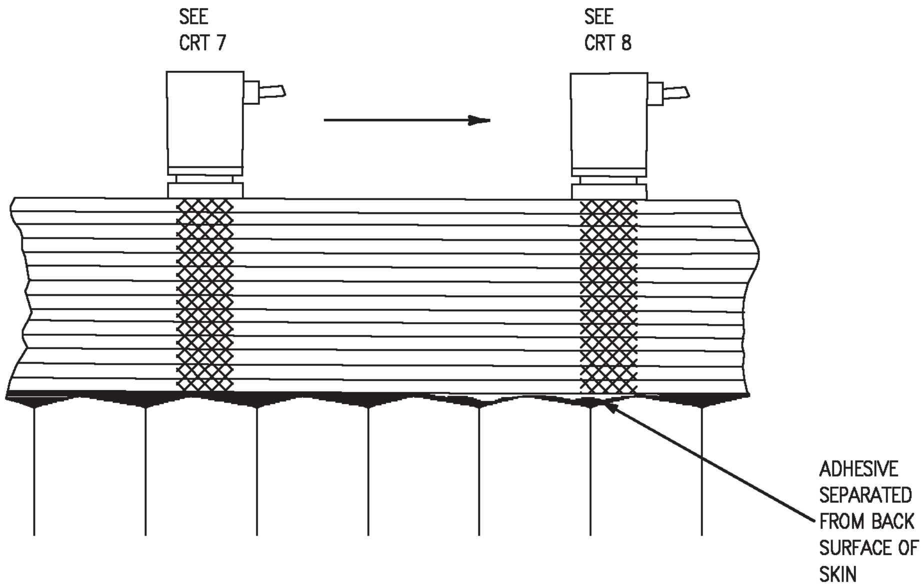
CRT 5

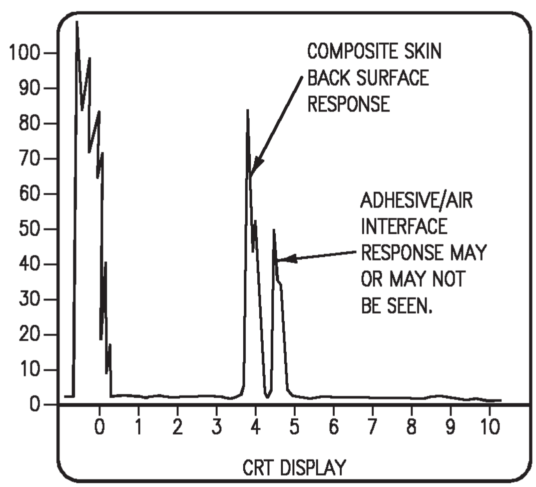


CRT 6

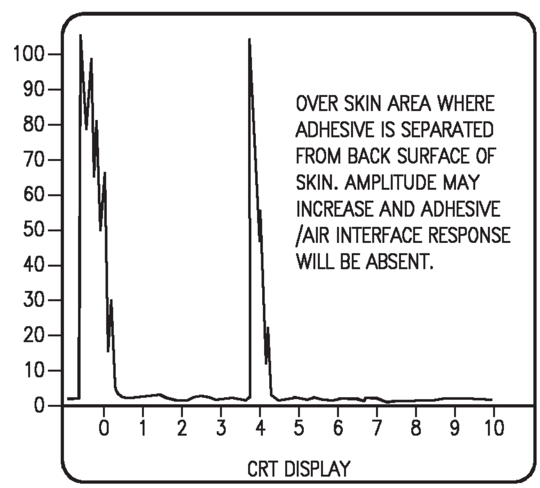
18AC-SRM-30-(432-4)32-SCAN

Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 4)





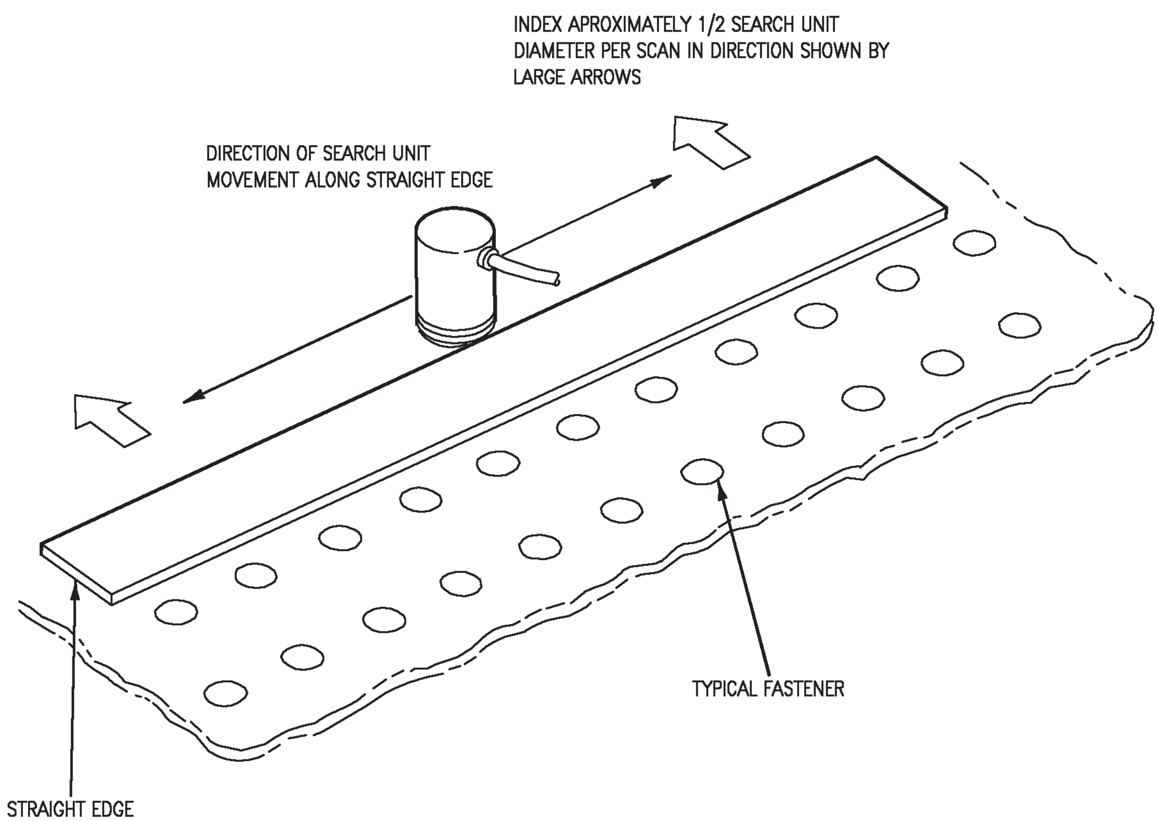
CRT 7



CRT 8

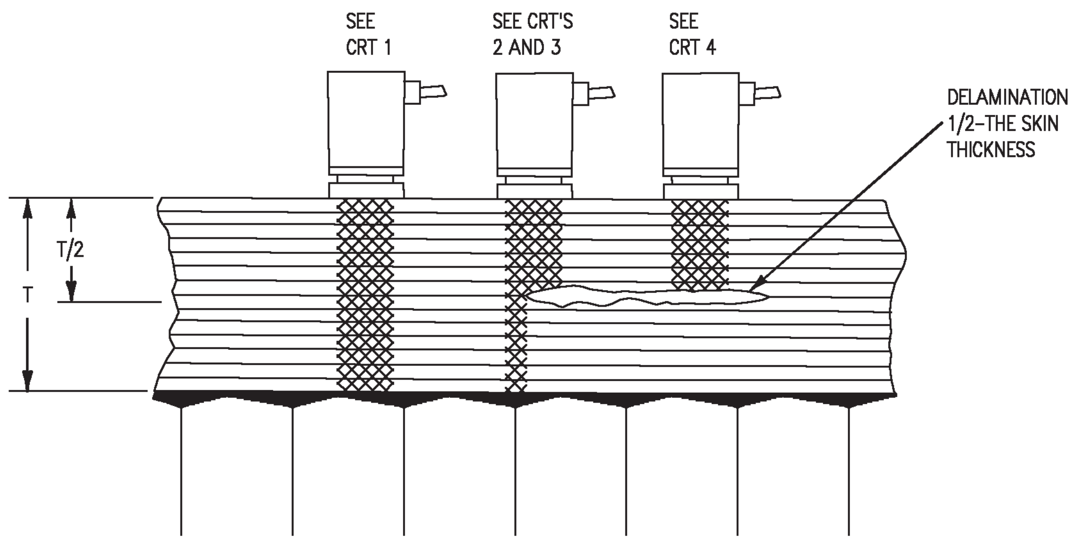
18AC-SRM-30-(432-5)32-SCAN

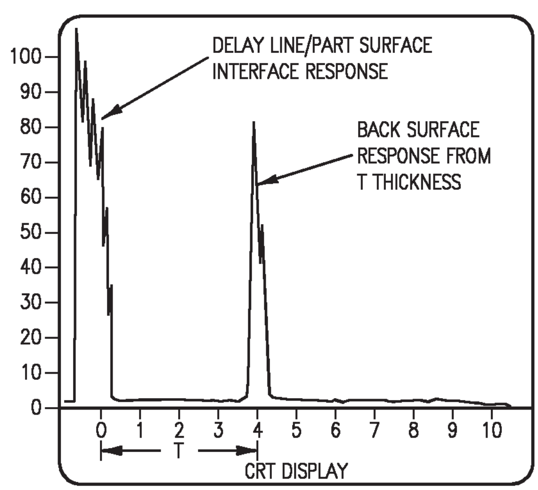
Figure 4. Typical Inspecting Responses of Composite Skin Bonded to Honeycomb Core (Sheet 5)



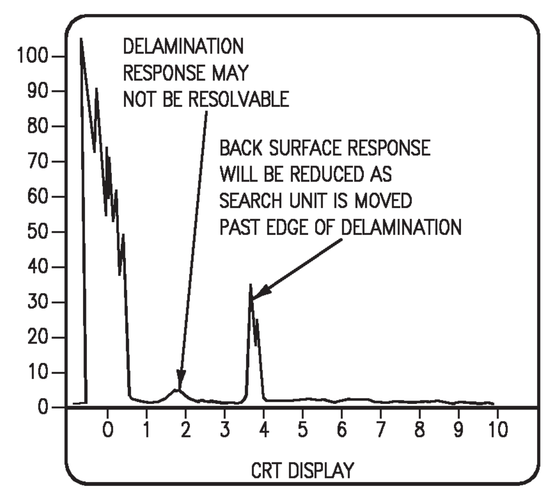
18AC-SRM-30-(433-1)32-SCAN

Figure 5. Scanning With Straight Edge





CRT 1



CRT 2

18AC-SRM-30-(434-1)32-SCAN

Figure 6. Flaws Located at One Half the Composite Skin Thickness (Sheet 1)

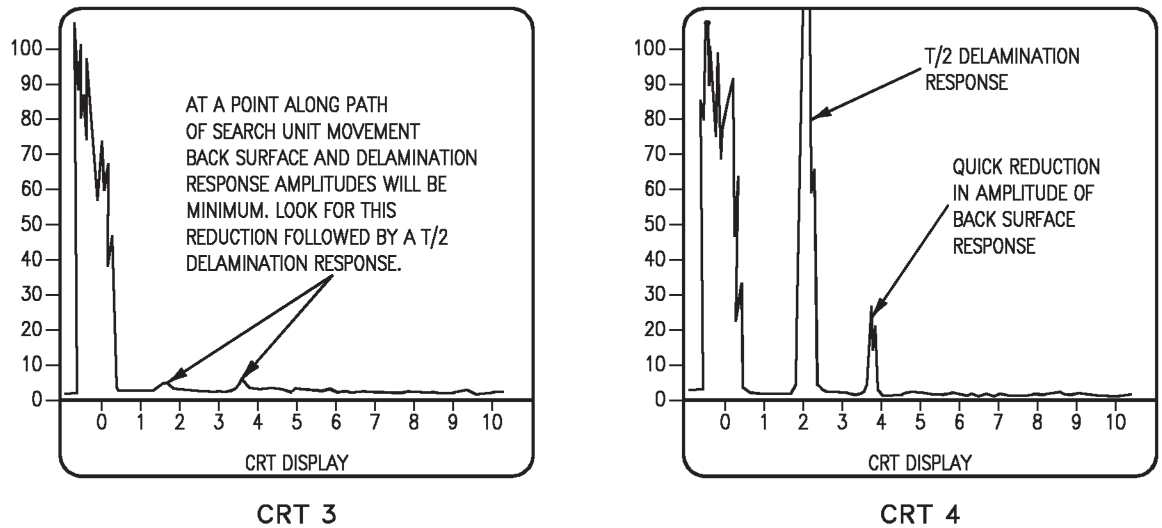
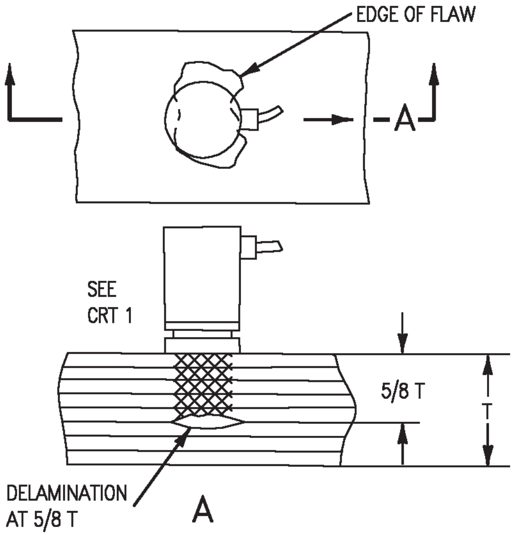
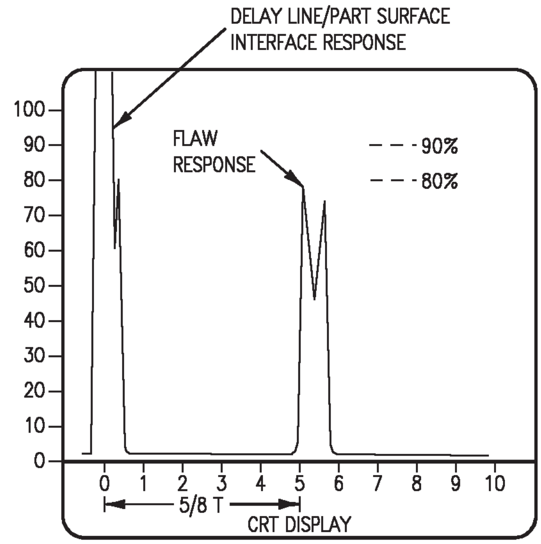
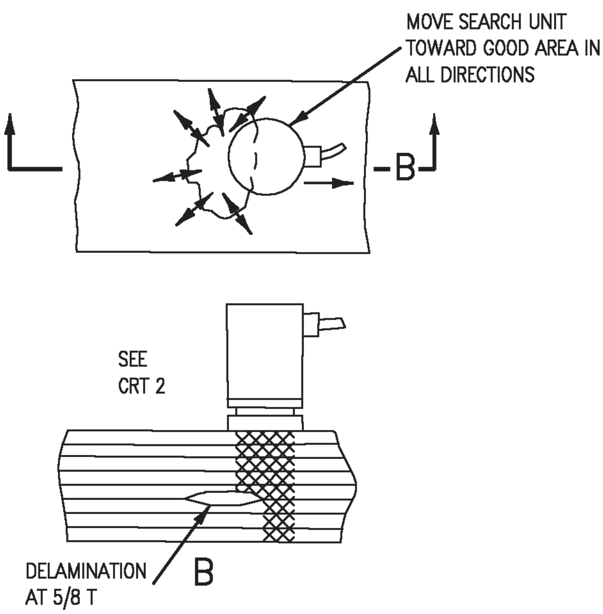


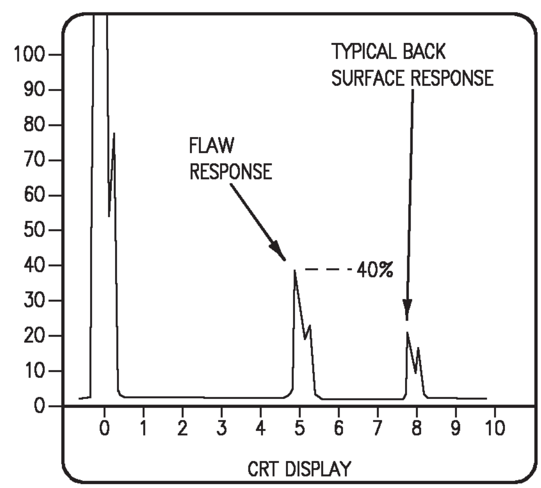
Figure 6. Flaws Located at One Half the Composite Skin Thickness (Sheet 2)





CRT 1





CRT 2

18AC-SRM-30-(435-1)32-SCAN

Figure 7. One Half Amplitude Mapping With Delay Line Search Unit Setup (Sheet 1)

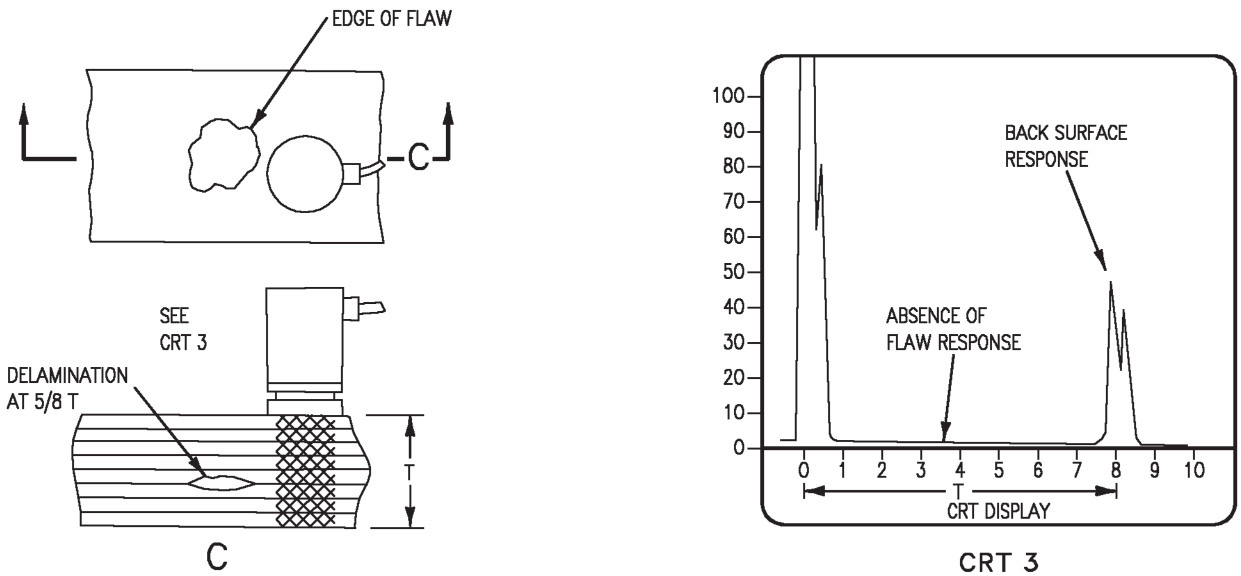
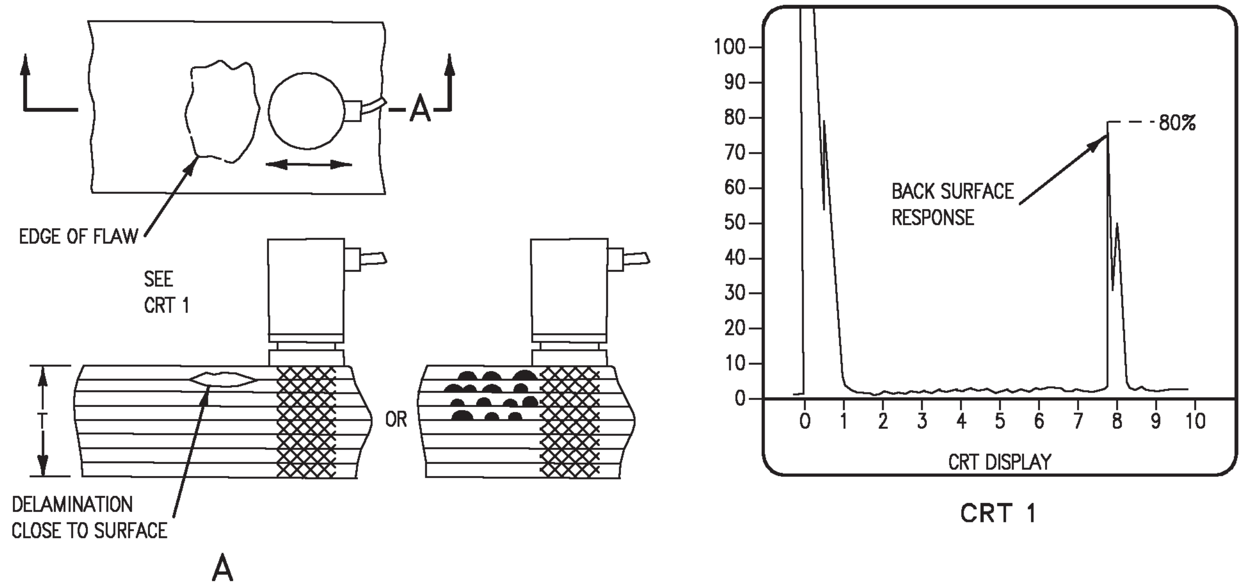
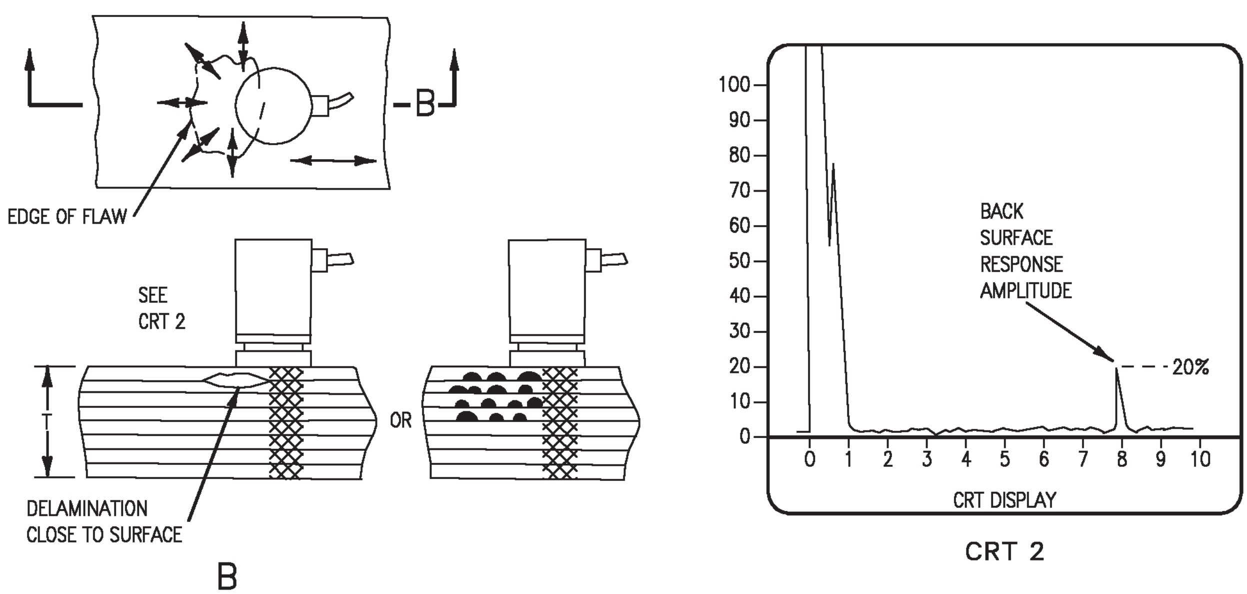


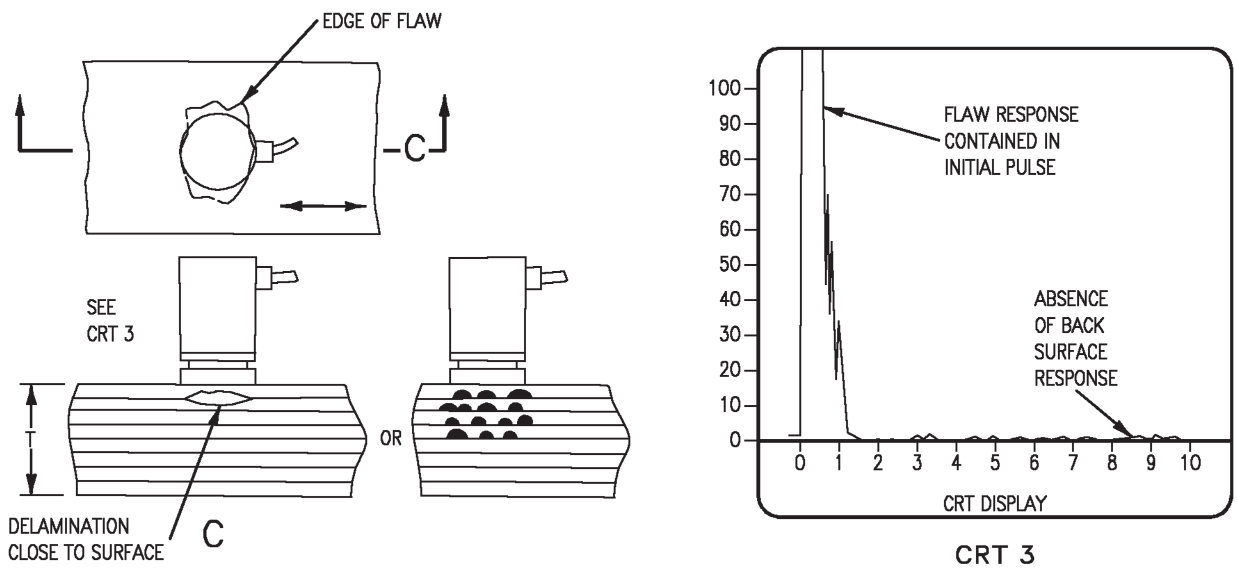
Figure 7. One Half Amplitude Mapping With Delay Line Search Unit Setup (Sheet 2)





18AC-SRM-30-(436-1)32-SCAN

Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations (Sheet 1)



18AC-SRM-30-(436-2)32-SCAN

Figure 8. Amplitude Mapping for Flaws Close to Surface or Small Delaminations (Sheet 2)

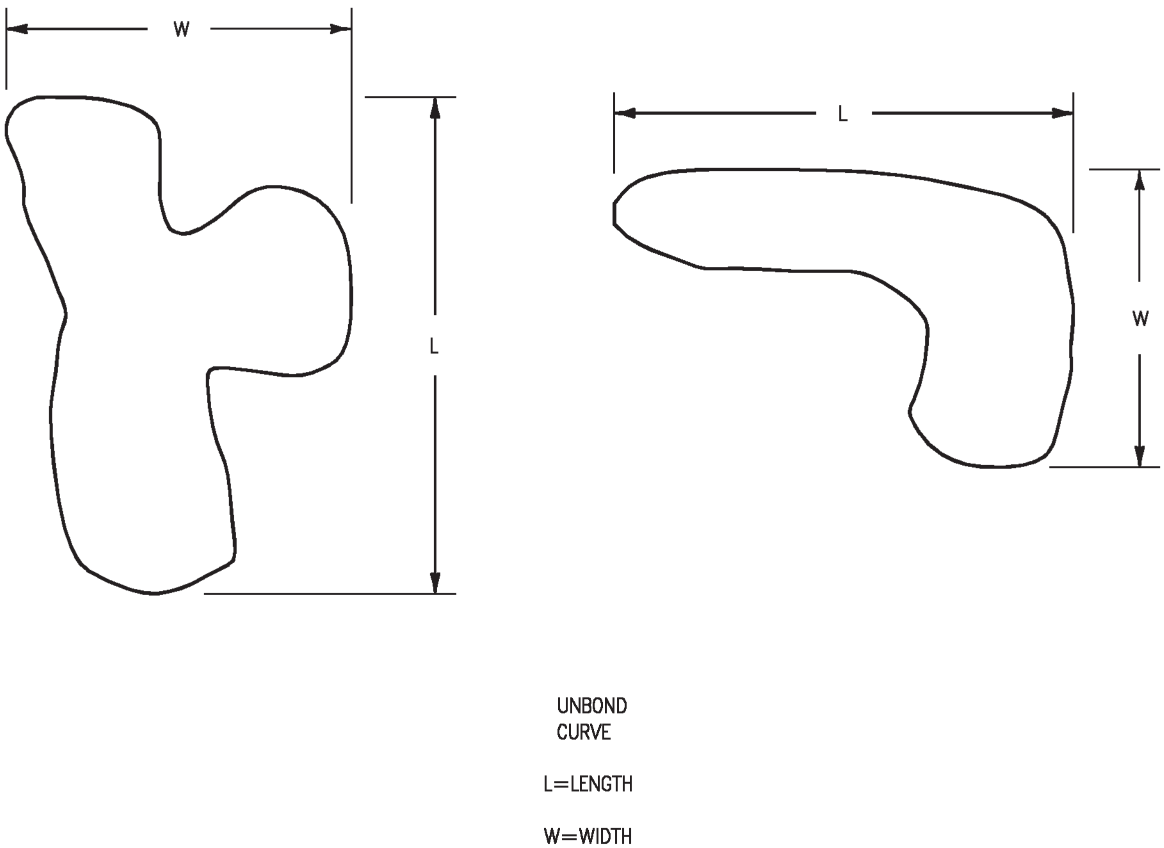


Figure 9. One Half Amplitude Mapping

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC METHOD

PULSE-ECHO SHEAR WAVE, ANGLE BEAM, CONTACT, OF METALLIC MATERIALS

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Pulse shear waves are used to inspect composite laminate materials. In pulse-echo mode, single search unit, or transducer, is used to both send and receive ultrasonic energy. Search unit introduces ultrasonic waves into part during transmit cycle. Same search unit is then used to receive reflected ultrasonic waves. Time required for reflected wave to travel through part and back to search unit, and amplitude of reflected wave are displayed on cathode ray tube (CRT) of ultrasonic flaw detector (tester). Defects or changes in acoustic properties of part result in responses which may be indicated by appearance of a spike on CRT and/or reduction in amplitude of reflected ultrasonic wave.

3. **SAFETY PRECAUTIONS.** Make sure safety requirements have been met for electrical, static, grounding before using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

4. **Personnel Qualifications.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

5. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
C-398	Ultrasonic Flaw Detector, Sonic Instruments

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A3052 or EQUIVALENT	45°S, 0.250" x 0.250", 5 MHz, Contact Delay Line Search Units
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 Type 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker
ULTRAGEL II	Ultrasonic Couplant
—	Clear Tape, Scotch Tape

6. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot cable.

b. Plug BNC end of microdot cable into tester, T or R BNC jack.

c. Turn tester ON, allow 15 minutes warm-up.

d. Set tester front face settings:

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COURSE SWEEP RANGE, FREQ, FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. If required, use alternate settings to produce optimum setup.

COARSE SWEEP RANGE	1.0 INCHES
ATTENUATORS	ALL OUT
FILTER	OFF
COARSE SWEEP DELAY	0 - 3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE-ECHO
FINE GAIN	MID SCALE
COARSE GAIN	APPROX 1
REP RATE	AUTO
FINE SWEEP RANGE	MIN
DAMPING	MID SCALE
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

e. An IIW-2 test block will be used during standardization and calibration for angle beam inspection of metallic materials.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

g. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY until initial pulse is located at zero on CRT horizontal

baseline. See figure 1, CRT 1. Flaw detector is now ready for standardization.

7. **Point of Incidence Determination.**

a. Begin with tester settings as described in paragraph 6d.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to IIW-2 test block at 0 mark. See figure 2.

NOTE

When maximum response is received from surface, “R”, as shown in figure 2, point of incidence on wedge should coincide with 0 marked on IIW-2 test block.

c. Position search unit at 0 mark on test block and move search unit back and forth to peak response from surface “R”. See figure 2.

d. Mark side of search unit using tube type marker at point of incidence, 0 mark on test block.

8. **Beam Angle Determination.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to position P1 or P2 on IIW-2 test block as shown in figure 3.

b. Position search unit at position P1 or P2 on test block and move search unit back and forth to peak signal reflected from hole in test block.

NOTE

Refracted angles from 30° to 80° may be measured.

c. Read actual refracted angle, on scale marked on test block near point P1 or P2, at point of incidence that has been marked on search unit wedge.

9. **Time-Base Standardization.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to IIW-2 test block at point marked 0 as shown in figure 1.

b. Position search unit at point marked 0 on IIW-2 test block.

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

c. Adjust GAIN, SWEEP DELAY, and SWEEP RANGE until two responses are received. See figure 1, CRT 1.

NOTE

Only one response will be received if search unit is near edge of IIW-2 test block.

d. Adjust FINE SWEEP RANGE until first response is located at 4 on CRT horizontal baseline. See figure 1, CRT 1.

e. Adjust FINE SWEEP DELAY to locate second response at 8 on CRT horizontal baseline. See figure 1, CRT 1.

f. If first response is no longer located at 4 on CRT horizontal baseline, relocate response using FINE SWEEP RANGE.

g. If second response is no longer located at 8 after adjusting FINE SWEEP RANGE, repeat steps

e. and f. until first response is located at 4 and second response is located at 8 on CRT horizontal baseline.

NOTE

CRT horizontal baseline is now calibrated for range of 5 inches of metal travel. Each of 10 large divisions on CRT horizontal baseline represents 0.5 inches of metal travel.

10. **Calibration: Distance Amplitude Curve, (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 11.

a. Determine applicable side drilled hole from specific procedure work package.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to IIW-2 test block at points P1 or P2 depending on side drilled hole specified in specific procedure work package. See figure 4.

c. Move search unit back and forth slightly to peak response from side drilled hole.

d. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT height. See figure 4, CRT 1.

e. Mark response position on CRT with tube type marker.

NOTE

Do not adjust GAIN for remainder of this DAC generation.

f. Position search unit at position P3 or P4 on IIW-2 test block, depending on side drilled hole size specified in specific procedure work package. See figure 4.

g. Maximize response by moving search unit back and forth slightly.

h. Mark amplitude of response on CRT with tube type marker. See figure 4, CRT 1.

i. Connect points on CRT with tube type marker to establish DAC as shown in figure 4, CRT 1.

NOTE

Skins with thickness greater than 0.250 inch, smooth DAC curve will not be received. Maximum responses will result from hole at multiple skip distances due to corner effect. See figure 5.

11. **Angle Beam Inspection Procedure.**

a. Visually inspect part and note flaws or nonconformities.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

c. The dB level selected during DAC establishment and add additional 6 dB sensitivity for scanning. If DAC is not specified in specific work package, add 6 dB to gain established in specific work package.

d. Complete setup and standardization procedures in paragraphs 6 through 9.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area. If large area is to be inspected, apply couplant to one small grid of inspection area to avoid couplant evaporation.

f. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 1/8 inch between scans. Unless other instructions specified in specific procedure work package, scan by passing search unit in linear direction while swiveling search unit from right to left within included angle of 40°. See figure 6, CRT 1. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, or edge. Where thickness changes occur at angle with respect to stiffeners, or edges, scan parallel to these areas. Scan at rate no greater than that established when detecting holes in IIW-2 test block. If grid is required, scan entire area within one grid block before inspecting next grid block.

g. Examples of flaw responses are described and illustrated in paragraphs 12 through 17, CRT Interpretation. If flaw is suspected during scanning, do steps listed below;

NOTE

When specific procedure requires DAC, and response is equal to or above DAC, mark part using half amplitude technique described in paragraph 10 and shown in figure 7 to determine flaw boundaries. If response is not equal to or less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

(1) Before identifying source of responses as crack, remove excess couplant from part surface in front of or on sides of search unit.

(2) Place search unit at different angle from suspected flaw location, preferably opposite previous location of search unit, and verify response is still received from suspected flaw.

(3) Maximize response by repositioning search unit and/or adding couplant.

(4) If DAC is being used, remove 6 dB of additional sensitivity added for inspection, and determine whether response amplitude is equal to or above DAC.

h. Use half-amplitude mapping technique, described in paragraph 18 and illustrated in figure 7, to mark flaw length on part surface using aircraft marking pencil.

i. Remove couplant from serviceable part after inspection.

12. **CRT Interpretation.**

NOTE

As search unit is moved toward edge, hole, crack, etc., general trend in response from edge, hole, crack, etc. will be increased amplitude and movement toward initial pulse; however, response will be maximized at certain regular distances from source known as skip distances. This is particularly evident in metals thicker than 0.250, see figure 5.

13. **Edge of Skin.** As search unit is moved closer to edge, general trend in edge response will be increased amplitude and movement toward initial pulse.

NOTE

To continually verify coupling is good, look for responses from natural reflectors such as edges or holes.

14. **Hole Responses.** Response from hole will generally increase in amplitude and move toward initial pulse as edge response does. See figure 6, CRT 3. If hole is near edge, edge response may or may not be visible in addition to hole response. See figure 6, CRT 4.

15. **Cracks at or Near Holes.** When crack occurs at or near hole, responses may be visible from both crack and hole. Responses from cracks occurring at holes may be very close to hole response on CRT horizontal baseline. See figure 6, CRT 5. Responses from crack and hole where crack occurs between search unit and hole are shown in figure 6, CRT 6.

16. **Cracks.** As search unit is moved toward crack, response from crack will generally increase in amplitude and shift toward initial pulse. Depending on search unit diameter compared to crack length and search unit location in relation to crack and skin edge, edge response may also be visible. See figure 6, CRT 7. Edge response should also generally increase in amplitude and move toward initial pulse as search unit is moved toward edge.

17. **Thickness Changes.** If possible, scan toward thicker sections at thickness changes, since responses can result from thickness changes when approaching thinner sections. See figure 6, CRTs 8 and 9. Scanning toward thinner section can mask flaws occurring at thickness change. Figure 6, CRT 10 shows response from crack at thickness change when scanning toward thicker section as specified. Response from crack will increase in amplitude and move toward initial pulse as search unit is moved toward crack.

18. **Half Amplitude Mapping.**

a. Adjust GAIN so maximum amplitude received from crack is approximately 95 percent full CRT height. See figure 7, CRT 1.

b. Move search unit parallel to defect while maintaining same sound travel distance. When crack CRT response drops to 45 to 50 percent full CRT height use aircraft marking pencil to mark part along centerline of search unit. See figure 7, CRT 2. Use this technique to mark both ends of flaw.

19. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

c. Do paragraph 36.

20. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

21. **Personnel Qualifications.** Personnel doing this nondestructive inspection must be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 Series, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
Support Equipment Required	
Part Number or Type Designation	Nomenclature
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A3052 or EQUIVALENT	45°S, 0.250" x 0.250", 5 MHz, Contact Delay Line Search Units
57A4243-16	Flat Bottom Hole Test Block, Steel
57A4243-30	Flat Bottom Hole Test Block, Aluminum
57A4244-30	IIW-2 Test Block, Aluminum
57A4244-18 Type 2	IIW-2 Test Block, Steel

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
COMMERCIAL	Tube Type Marker
ULTRAGEL II	Ultrasonic Couplant
—	Clear Tape, Scotch Tape

22. **Equipment Settings/Standardization/Setup, General.**

a. Connect search unit to Microdot cable.

b. Plug BNC end of microdot cable into tester, T or R BNC jack.

c. Turn tester ON, allow 5 minutes warm-up.

d. Set tester front face settings:

NOTE

Equipment differences may require use of alternate REP. RATE, DAMP., FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP RATE	AUTO
VOLT	HALF
DAMP	MIN
FREQ	SAME AS SEARCH UNIT
MODE	ECHO
GAIN (dB)	50 (dB)
COURSE GAIN	5
FINE GAIN	0
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	5
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	1
FINE	7.0
POLARITY	OFF
DISTANCE ECHO CORRECTION	OFF

e. An IIW-2 test block will be used during standardization and calibration for angle beam inspection of metallic materials.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

f. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

g. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY until initial pulse is located at zero on CRT horizontal baseline. See figure 1, CRT 1. Flaw detector is now ready for standardization.

23. **Point of Incidence Determination.**

a. Begin with tester settings as described in paragraph 22d.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to IIW-2 test block at 0 mark. See figure 2.

NOTE

When maximum response is received from surface, “R”, as shown in figure 2, point of incidence on wedge should coincide with 0 marked on IIW-2 test block.

c. Position search unit at 0 mark on test block and move search unit back and forth to peak response from surface “R”. See figure 2.

d. Mark side of search unit using tube type marker at point of incidence, 0 mark on test block.

24. **Beam Angle Determination.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to position P1 or P2 on IIW-2 test block as shown in figure 3.

b. Position search unit at position P1 or P2 on test block and move search unit back and forth to peak signal reflected from hole in test block.

NOTE

Refracted angles from 30° to 80° may be measured.

c. Read actual refracted angle, on scale marked on test block near point P1 or P2, at point of incidence that has been marked on search unit wedge.

25. **Time-Base Standardization.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to IIW-2 test block at point marked 0 as shown in figure 1.

b. Position search unit at point marked 0 on IIW-2 test block.

c. Adjust GAIN, HORIZONTAL SWEEP DELAY, and LENGTH until two responses are received. See figure 1, CRT 1.

NOTE

Only one response will be received if search unit is near edge of IIW-2 test block.

d. Adjust HORIZONTAL SWEEP LENGTH until first response is located at 4 on CRT horizontal baseline. See figure 1, CRT 1.

e. Adjust HORIZONTAL SWEEP FINE DELAY to locate second response at 8 on CRT horizontal baseline. See figure 1, CRT 1.

f. If first response is no longer located at 4 on CRT horizontal baseline, relocate response using HORIZONTAL SWEEP FINE LENGTH.

g. If second response is no longer located at 8 after adjusting HORIZONTAL SWEEP FINE LENGTH, repeat steps e. and f. until first response is located at 4 and second response is located at 8 on CRT horizontal baseline.

NOTE

CRT horizontal baseline is now calibrated for range of 5 inches of metal travel. Each of 10 large divisions on CRT horizontal baseline represents 0.5 inches of metal travel.

26. **Calibration: Distance Amplitude Curve, (DAC).**

NOTE

If DAC curve is not required for specific procedure, go to paragraph 27.

CAUTION

Do not use grease pencil mark directly on face of CRT filter. Damage to components will occur.

a. Apply clear tape to CRT screen filter so DAC curve can be marked on tape.

b. Determine applicable side drilled hole from specific procedure work package.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

c. Apply couplant to IIW-2 test block at points P1 or P2 depending on side drilled hole specified in specific procedure work package. See figure 4.

d. Move search unit back and forth slightly to peak response from side drilled hole.

e. Adjust GAIN until side drilled hole response is approximately 90 percent full CRT height. See figure 4, CRT 1.

f. Mark response position on tape covering CRT filter with tube type marker.

NOTE

Do not adjust GAIN for remainder of this DAC generation.

g. Position search unit at position P3 or P4 on IIW-2 test block, depending on side drilled hole size specified in specific procedure work package. See figure 4.

h. Maximize response by moving search unit back and forth slightly.

i. Mark amplitude of response on tape covering CRT filter with tube type marker. See figure 4, CRT 1.

j. Connect points on tape covering CRT filter with tube type marker to establish DAC as shown in figure 4, CRT 1.

NOTE

Skins with thickness greater than 0.250 inch, smooth DAC curve will not be received. Maximum responses will result from hole at multiple skip distances due to corner effect. See figure 5.

27. **Angle Beam Inspection Procedure.**

a. Visually inspect part and note flaws or nonconformities.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

c. The dB level selected during DAC establishment and add additional 6 dB sensitivity for scanning. If DAC is not specified in specific work package, add 6 dB to gain established in specific work package.

d. Complete setup and standardization procedures in paragraph 22 through 25.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to inspection area. If large area is to be inspected, apply couplant to one small grid of inspection area to avoid couplant evaporation.

f. Using pulse-echo, scan inspection area per scan plan, indexing, scan direction, and scan rate, in specific procedure work package. When index dimension is not detailed in specific work package, index 1/8 inch between scans. Unless other instructions specified in specific procedure work package, scan by passing search unit in linear direction while swiveling search unit from right to left within included angle of 40°. See figure 6, CRT 1. If scan direction is not given in specific work package, scan parallel to thickness changes, stiffeners, or edge. Where thickness changes occur at angle with respect to stiffeners, or edges, scan parallel to these areas. Scan at rate no greater than that established when detecting holes in IIW-2 test block. If grid is required, scan entire area within one grid block before inspecting next grid block.

g. Examples of flaw responses are described and illustrated in paragraphs 28. through 33., CRT Interpretation. If flaw is suspected during scanning, do following;

NOTE

When specific procedure requires DAC, and response is equal to or above DAC, mark part using half amplitude technique described in paragraph 26 and shown in figure 7 to determine flaw boundaries. If response is not equal to or less than DAC, disregard response and continue on with inspection after adding extra 6 dB of sensitivity. If DAC is not being used, reject flaws per specific work package or structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750).

(1) Before identifying source of responses as crack, remove excess couplant from part surface in front of or on sides of search unit.

(2) Place search unit at different angle from suspected flaw location, preferably opposite previous location of search unit, and verify response is still received from suspected flaw.

(3) Maximize response by repositioning search unit and/or adding couplant.

(4) If DAC is being used, remove 6 dB of additional sensitivity added for inspection, and determine whether response amplitude is equal to or above DAC.

h. Use half-amplitude mapping technique, described in paragraph 34 and illustrated in figure 7, to mark flaw length on part surface using aircraft marking pencil.

i. Remove couplant from serviceable part after inspection.

28. **CRT Interpretation.**

NOTE

> As search unit is moved toward edge, hole, crack, etc., general trend in response from edge, hole, crack, etc. will be increased amplitude and movement toward initial pulse; however, response will be maximized at certain regular distances from source known as skip distances. This is particularly evident in metals thicker than 0.250 inch. See figure 5.

29. **Edge of Skin.** As search unit is moved closer to edge, general trend in edge response will be increased amplitude and movement toward initial pulse.

NOTE

> To continually verify coupling is good, look for responses from natural reflectors such as edges or holes.

30. **Hole Responses.** Response from hole will generally increase in amplitude and move toward initial pulse as edge response does. See figure 6, CRT 3. If hole is near edge, edge response may or may not be visible in addition to hole response. See figure 6, CRT 4.

31. **Cracks at or Near Holes.** When crack occurs at or near hole, responses may be visible from both crack and hole. Responses from cracks occurring at holes may be very close to hole response on CRT horizontal baseline. See figure 6, CRT 5. Responses from crack and hole where crack occurs between search unit and hole are shown in figure 6, CRT 6.

32. **Cracks.** As search unit is moved toward crack, response from crack will generally increase in amplitude and shift toward initial pulse. Depending on search unit diameter compared to crack length and search unit location in relation to crack and skin edge, edge response may also be visible. See figure 6, CRT 7. Edge response should also generally increase in amplitude and move toward initial pulse as search unit is moved toward edge.

33. **Thickness Changes.** If possible, scan toward thicker sections at thickness changes, since responses can result from thickness changes when approaching thinner sections. See figure 6, CRTs 8 and 9. Scanning toward thinner section can mask flaws occurring at thickness change. Figure 6, CRT 10 shows response from crack at thickness change when scanning toward thicker section as specified. Response from crack will increase in amplitude and move toward initial pulse as search unit is moved toward crack.

34. **Half Amplitude Mapping.**

a. Adjust GAIN so maximum amplitude received from crack is approximately 95 percent full CRT height. See figure 7, CRT 1.

b. Move search unit parallel to defect while maintaining same sound travel distance. When crack CRT response drops to 45 to 50 percent full CRT height use aircraft marking pencil to mark part along centerline of search unit. See figure 7, CRT 2. Use this technique to mark both ends of flaw.

35. **Acceptance Criteria.**

a. Damage limits for inspection area should be listed in specific work package for each inspection area. If this information is not included in specific work package, refer to structure repair manuals (A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 through A1-F18AE-SRM-750) for inspection area.

b. Defined damage limits should include acceptable delamination size, acceptable number of flaws per area, and criteria for delaminations that overlap areas on part.

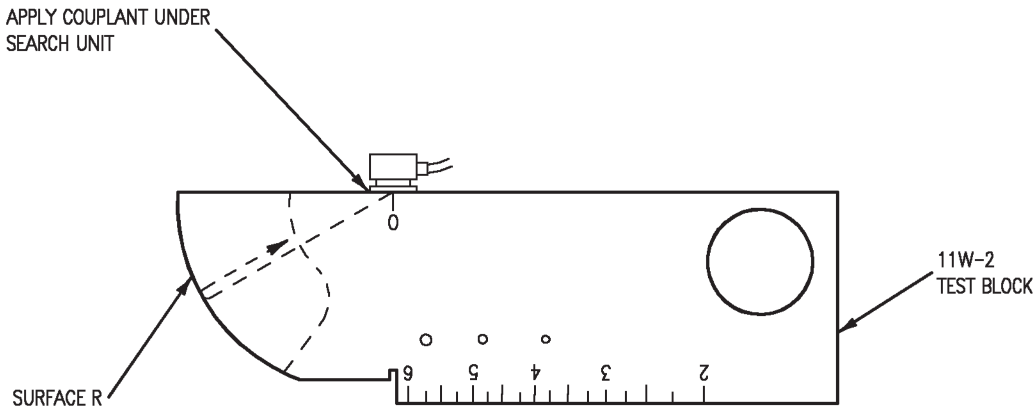
WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

36. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. Allow to dry for 15 minutes after cleaning.



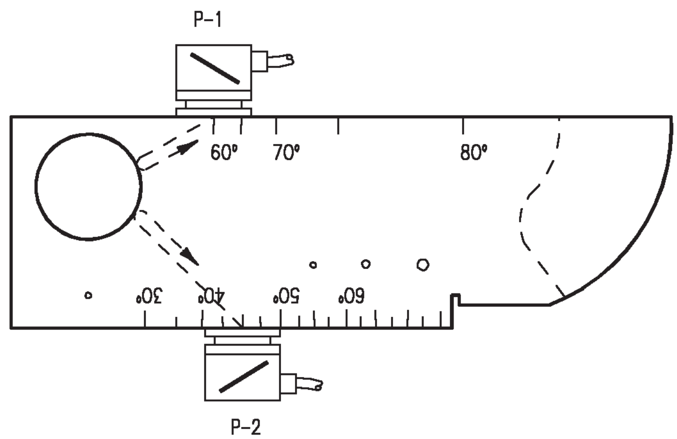
LEGEND

TO DETERMINE SOUND POINT OF INCIDENCE:

1. MAXIMIZE RESPONSE FROM SURFACE R.
2. SEARCH UNIT POINT OF INCIDENCE SHOULD COINCIDE WITH 0 ON 11W-2 TEST BLOCK.
3. MARK POINT AT 0 ON SIDE OF SEARCH UNIT.

18AC-SRM-30-(438-1)32-CATI

Figure 1. Point of Incidence Determination



LEGEND

TO DETERMINE BEAM ANGLE:

1. MAXIMIZE RESPONSE FROM HOLE.

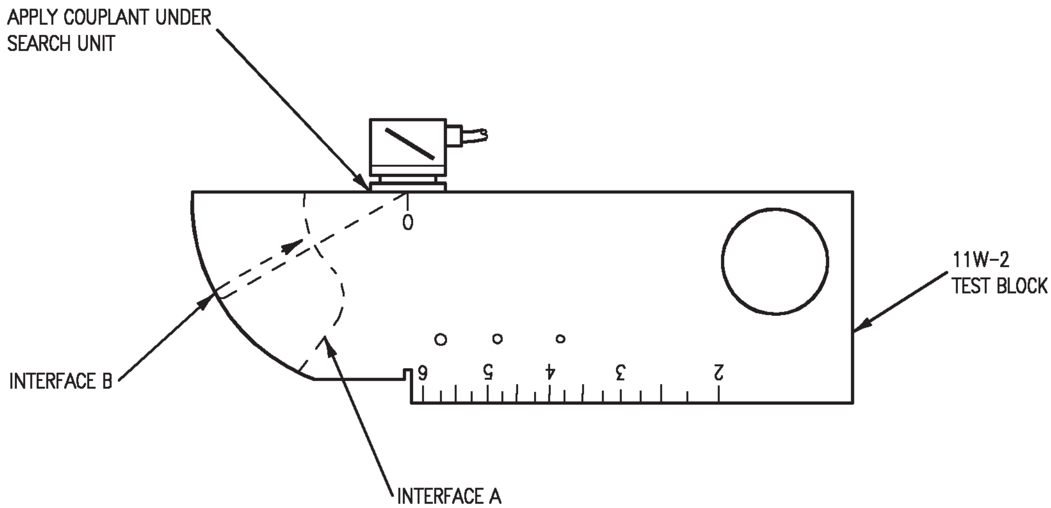
2. READ ACTUAL REFRACTION ON SCALE MARKED ON 11W-2 TEST BLOCK AT SOUND POINT OF INCIDENCE.

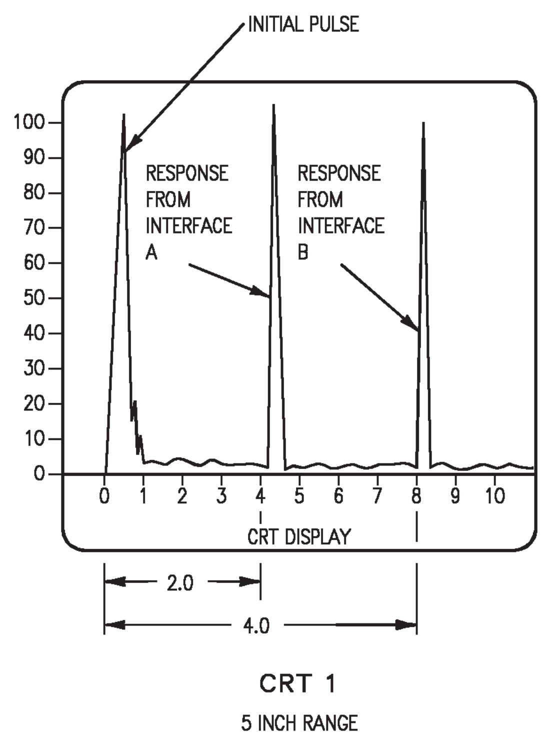
3. BEAM ANGLES FOR SEARCH UNITS SHOWN ARE:

   P-1 : 60°
   P-2 : 45°

18AC-SRM-30-(439-1)32-SCAN

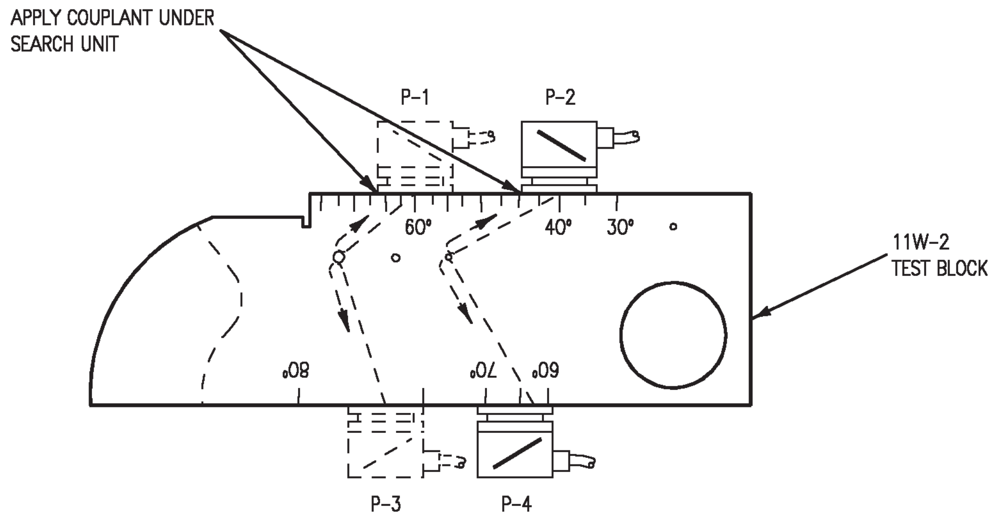
Figure 2. Beam Angle Determination

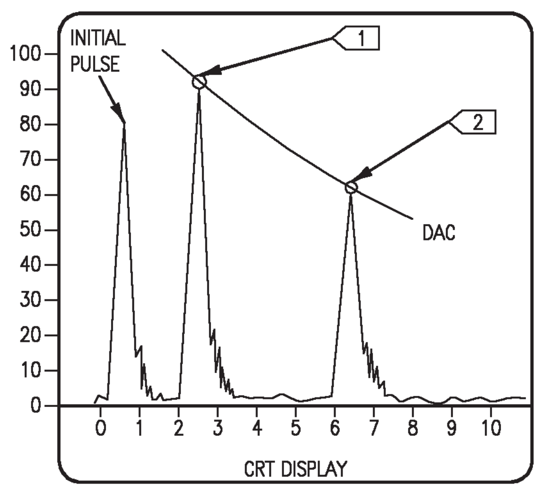




18AC-SRM-30-(440-1)32-CATI

Figure 3. Angle Beam Time Base Standardization





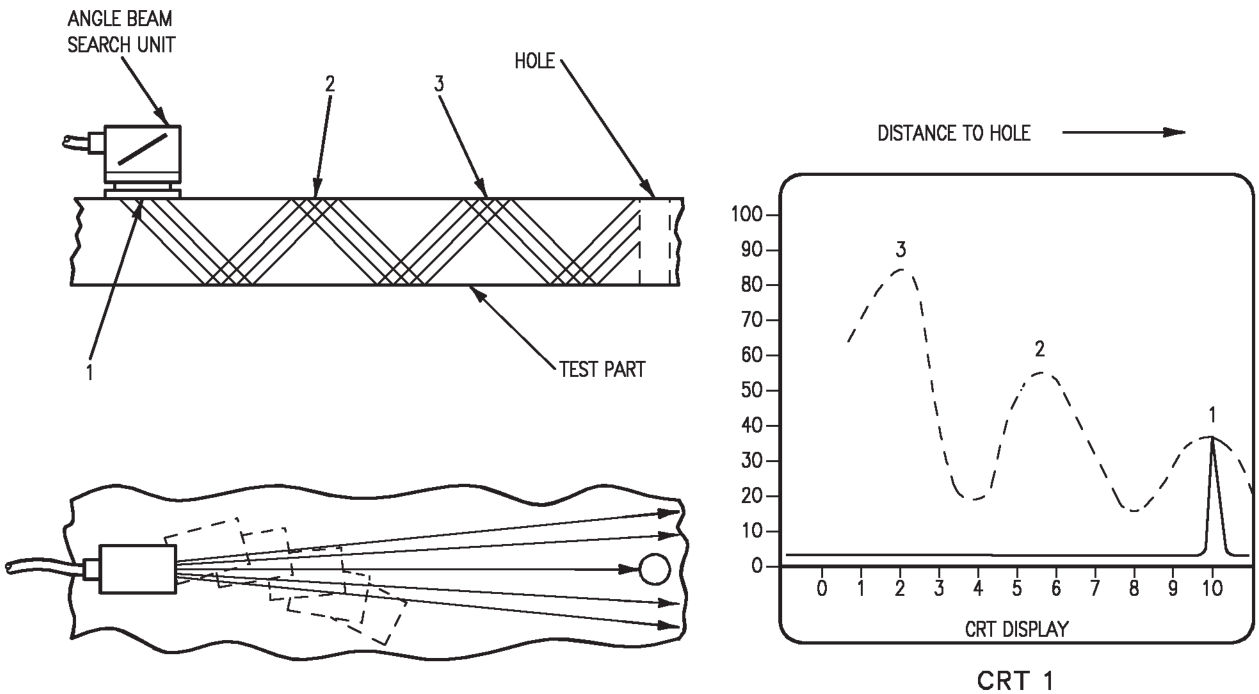
CRT 1

LEGEND

1. SET RESPONSE FROM SIDE DRILLED HOLE TO 90 PERCENT OF FULL SCREEN HEIGHT WITH SEARCH UNIT AT P-1 OR P-2. REFER TO SPECIFIC WORK PACKAGE TO DETERMINE WHICH HOLE IS TO BE USED FOR STANDARDIZATION.
2. RESPONSE FROM SIDE DRILLED HOLE WITH SEARCH UNIT AT P-3 OR P-4.
3. CONNECT POINTS FROM P-1 OR P-2 AND P-3 OR P-4 TO FORM DAC.

18AC-SRM-30-(441-1)32-SCAN

Figure 4. Development of Distance Amplitude Curve (DAC) for Angle Beam, For Skin Thickness Up to 1/4 Inch

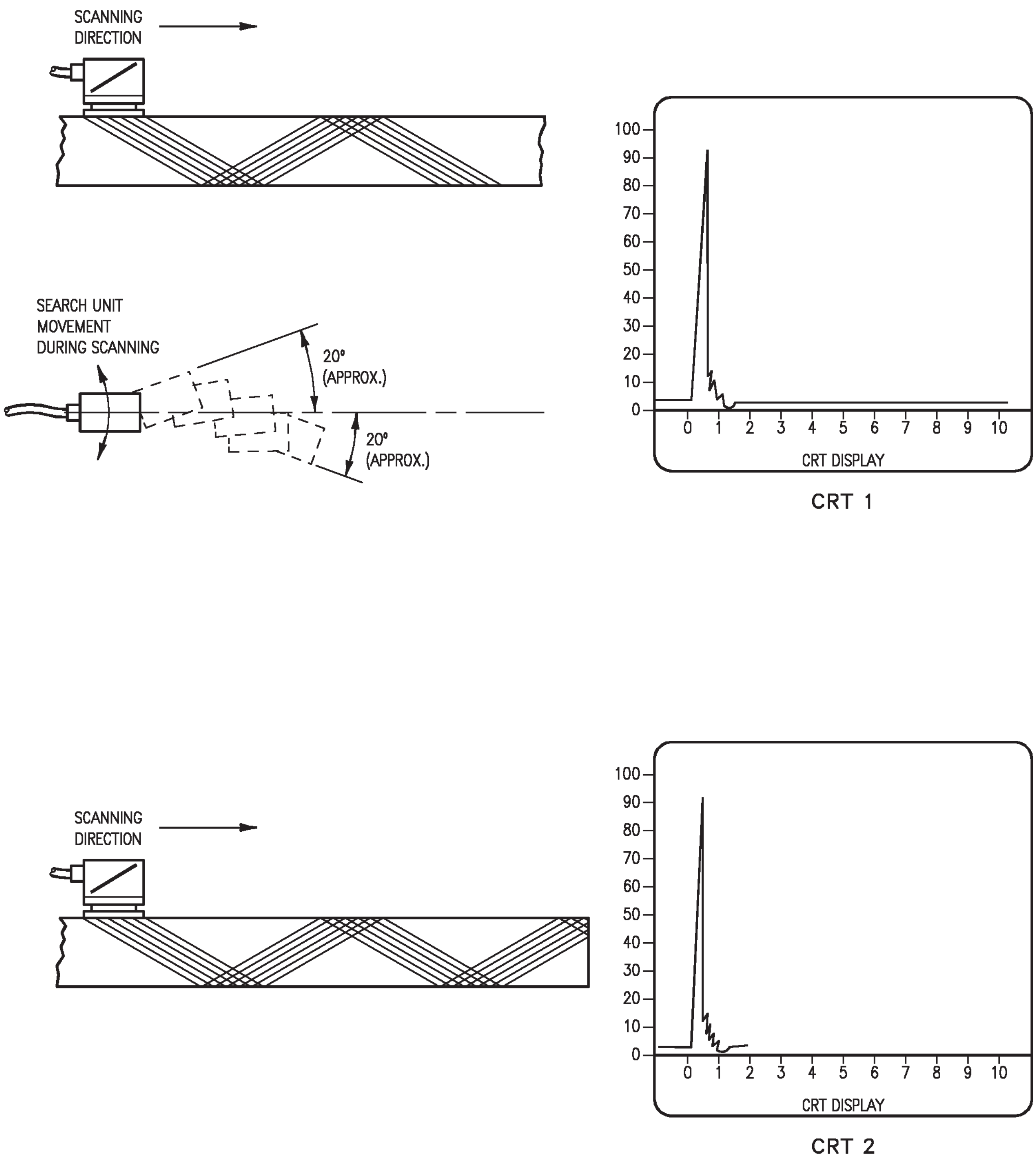


NOTE

IRREGULAR DAC CURVE IS RECEIVED BECAUSE OF CORNER EFFECT. RESPONSE FROM HOLE IS MAXIMIZED WHEN CENTER OF SOUND BEAM MEETS INTERSECTION OF HOLE AND TEST PART SURFACE. THIS HAPPENS WHEN SEARCH UNIT IS AT POSITION 1, 2, AND 3. METAL TRAVEL DISTANCE FROM POINT 1 TO POINT 2 IS EQUAL TO 1 SKIP DISTANCE.

18AC-SRM-30-(442-1)32-SCAN

Figure 5. Irregular DAC Curve Received From Skin Thicker Than 1/4 Inch



18AC-SRM-30-(443-1)32-SCAN

Figure 6. Typical Responses (Sheet 1)

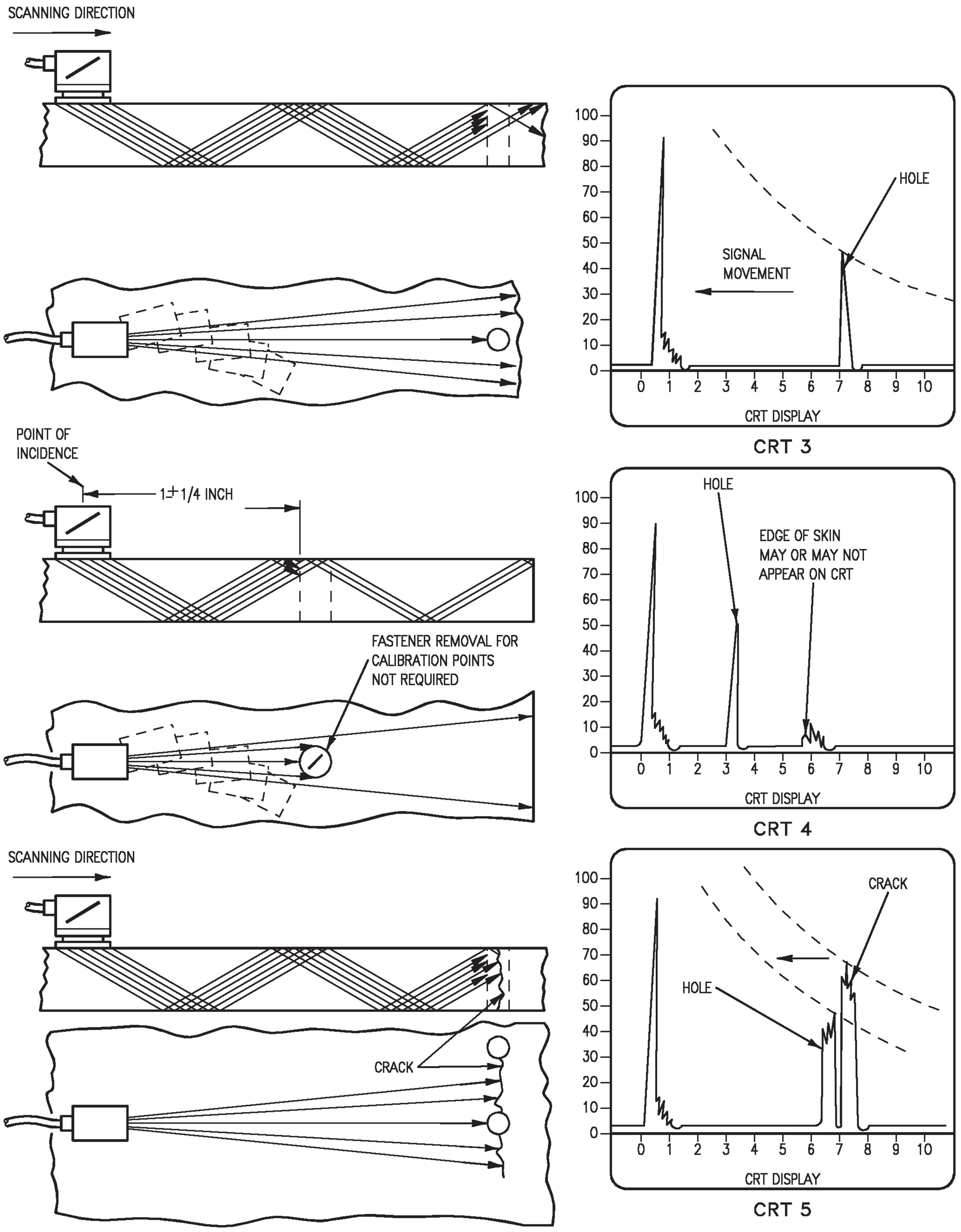


Figure 6. Typical Responses (Sheet 2)

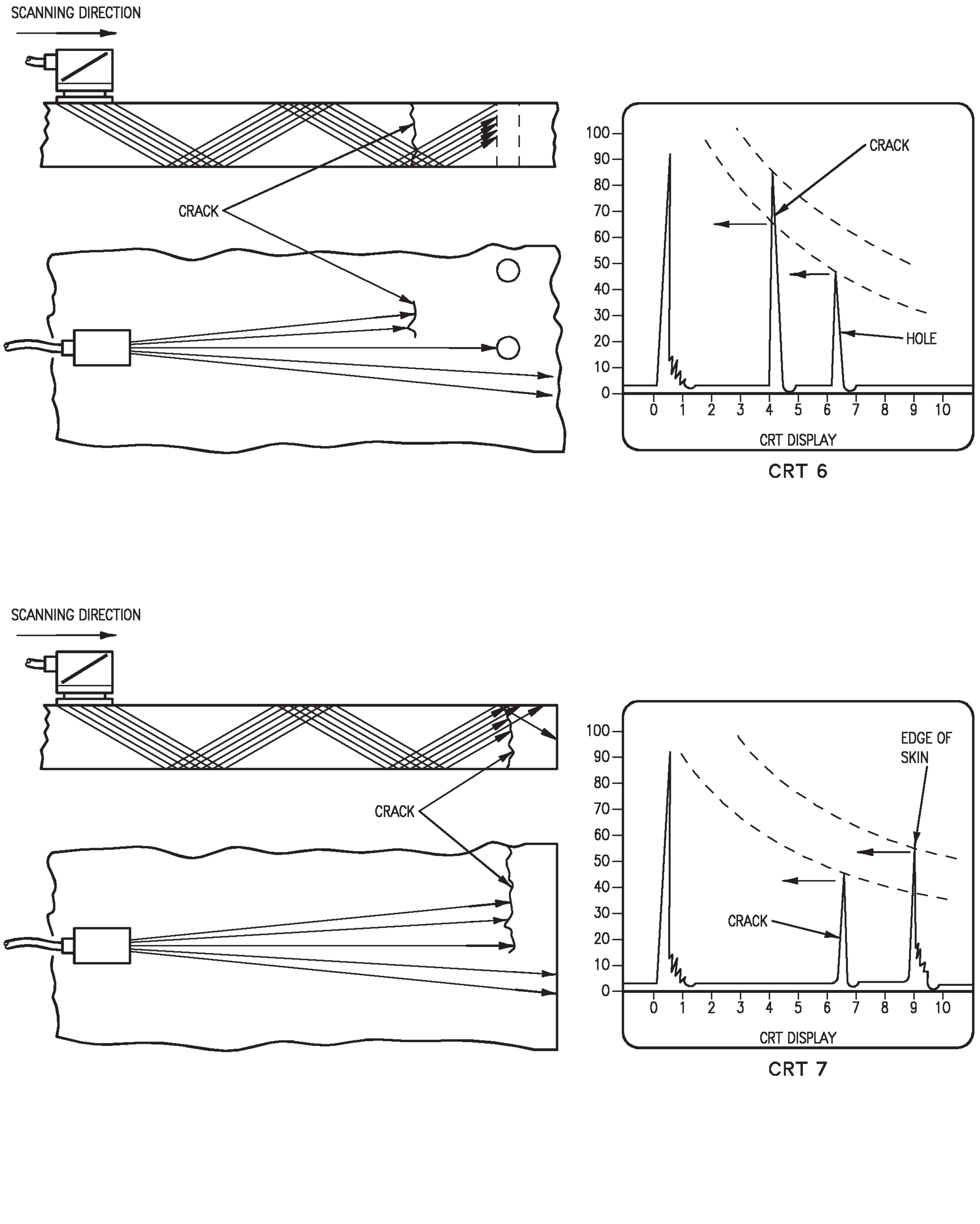


Figure 6. Typical Responses (Sheet 3)

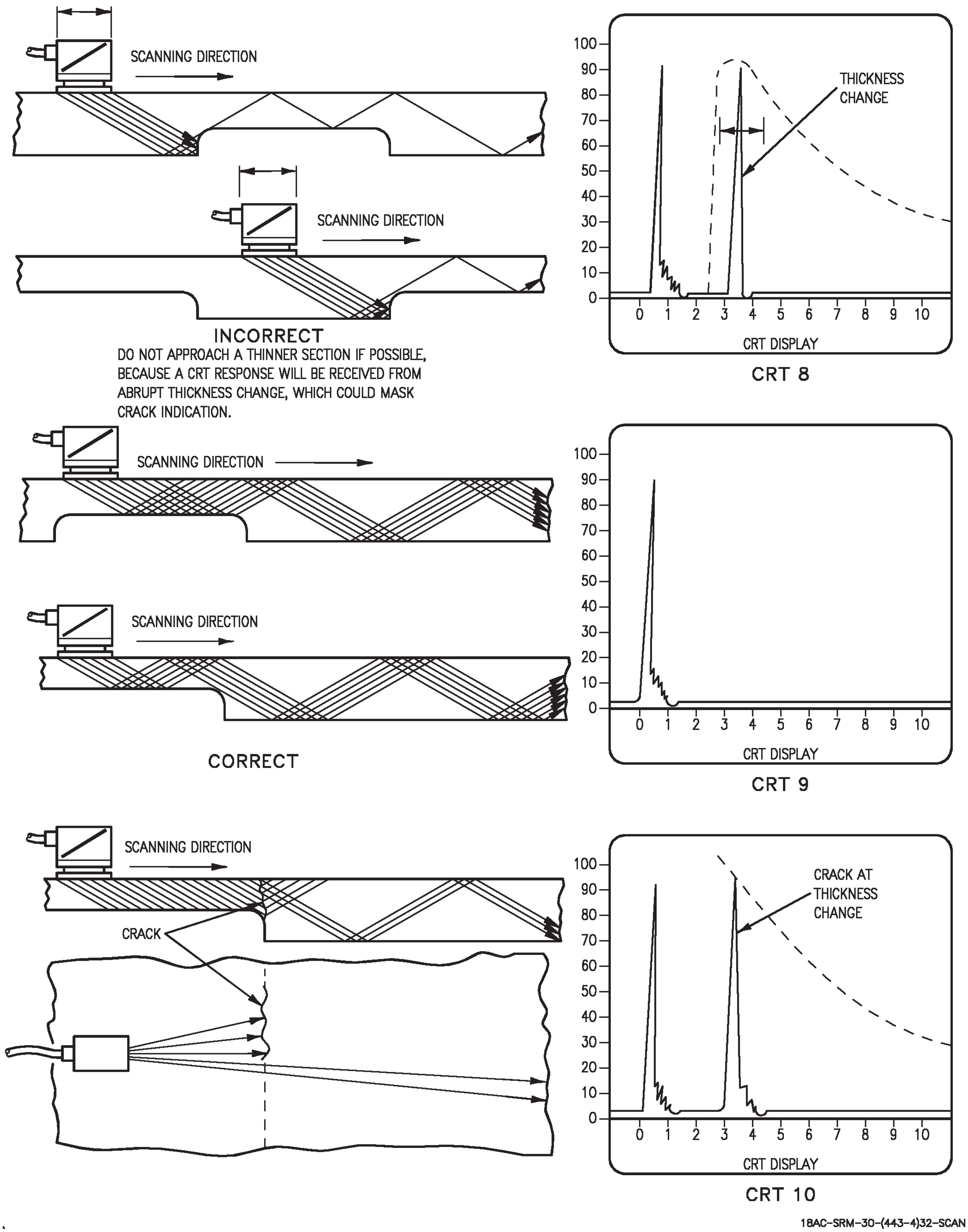


Figure 6. Typical Responses (Sheet 4)

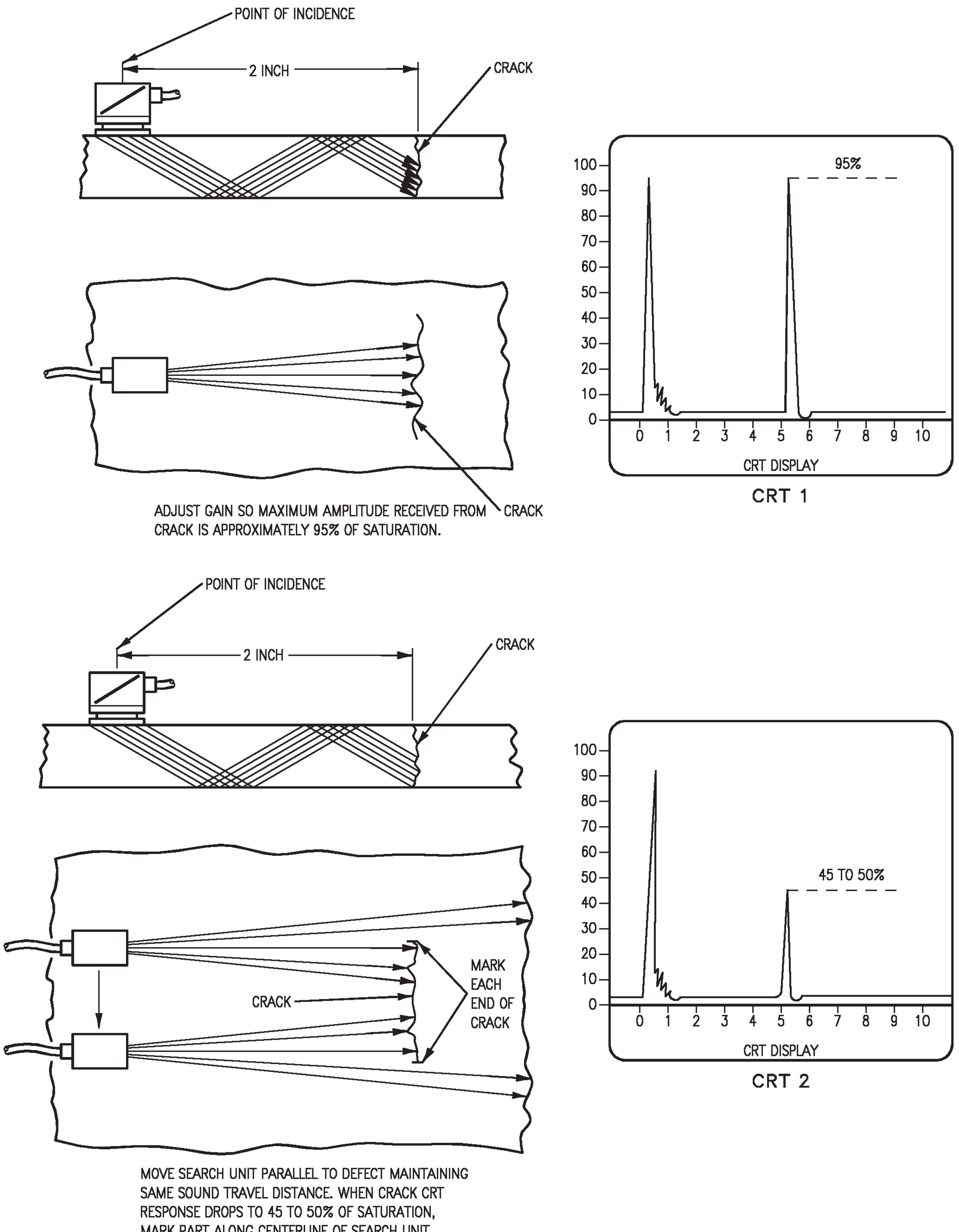


Figure 7. Half Amplitude Mapping

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

AILERON

WATER IN HONEYCOMB

PART NO. 74A170004

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Integrated Flight Controls	A1-F18AC-570-300
Aileron and Aileron Shroud	WP010 00
Nondestructive Inspection	A1-F18AC-SRM-300
Radiographic Method	WP005 00
General Information	WP003 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **AILERON.**

2. The aileron is a bonded honeycomb assembly. Honeycomb core is 0.125, 0.156, and 0.188 hexagonal cell, 5056 aluminum alloy. Skin and structure enclosing honeycomb core is 7075 aluminum. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX M FILM CODE M-2 or IN-DUSTREXAA FILMCODE14X17	Radiographic Film 14 x 17, 7 x 14, 7 x 17
MIL-P-83953-2 TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inboard hinge fairing, 74A170624, removed (A1-F18AC-570-300, WP010 00).

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per technique chart. See figure 1.

10. **Inspection Procedure.**

NOTE

X-ray film for shots are double loaded. AA film is located next to part and both films are exposed simultaneously.

a. Locate films 1 and 2 for shot 1. Film should be taped to upper surface of aileron with identification markers taped to source side of film pack and penetrameters taped on source side of aileron.

b. Locate source to aiming point for shot 1. Source should be normal to aiming point.

c. Expose films 1 and 2 using technique chart for shot 1. Remove exposed films from aileron.

d. Repeat steps a through c for films 3 and 4 and shot 2.

e. Repeat steps a through c for films 5 and 6 and shot 3.

f. Repeat steps a through c for films 7, 8, and 9 and shot 4.

g. Repeat steps a through c for film 10 and shot 5.

h. Repeat steps a through c for film 11 and shot 6.

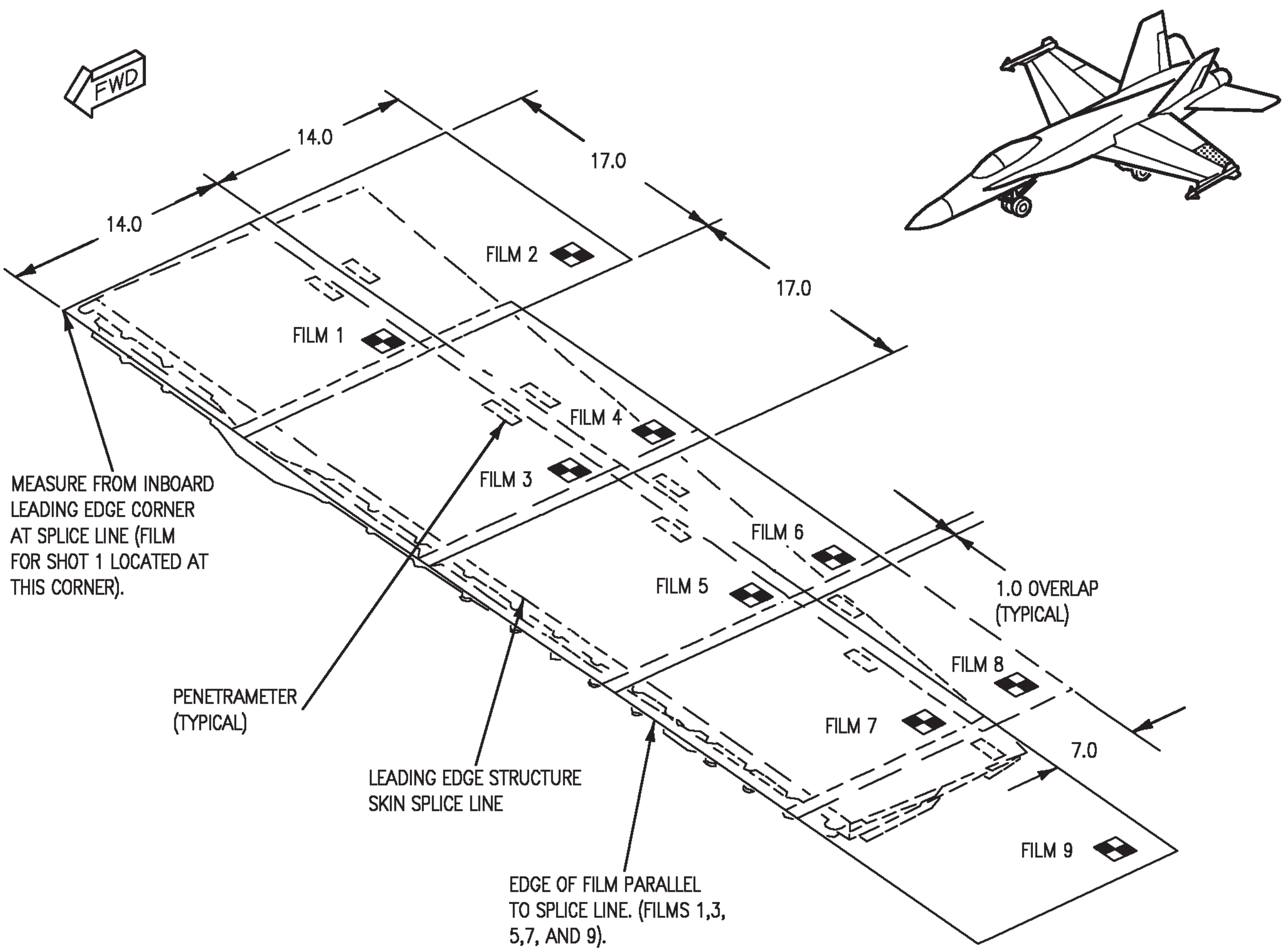
i. Repeat steps a through c for film 12 and shot 7.

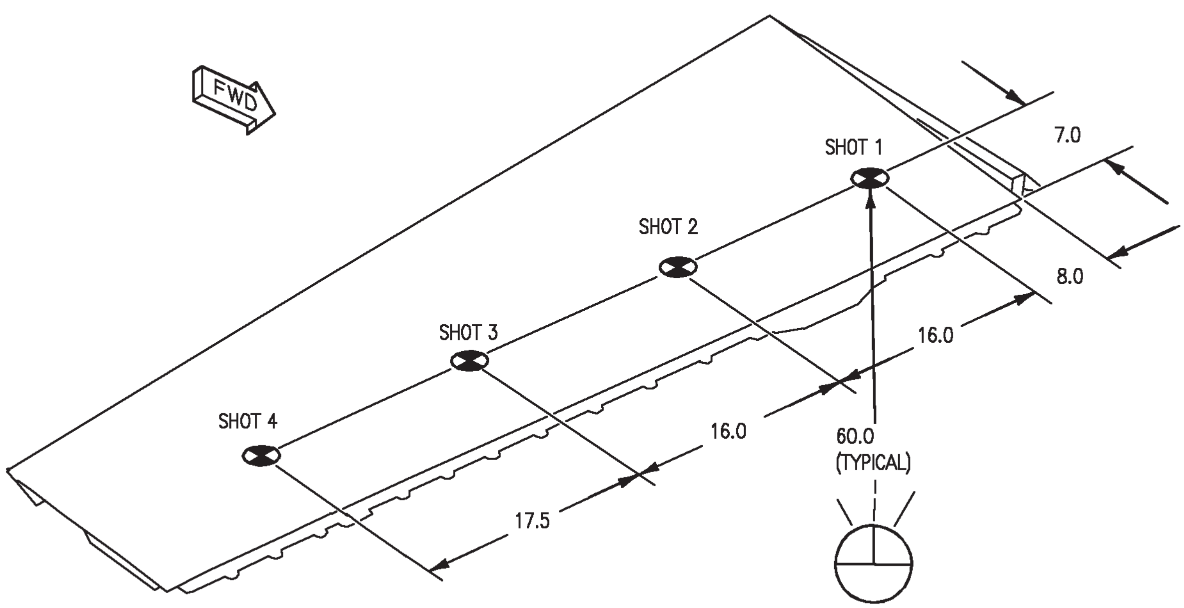
j. Repeat steps a through c for films 13 and 14 and shot 8.

k. Process exposed films. Interpret radiographs for water trapped in honeycomb core (WP005 00).

l. Mark defect(s) using aircraft marking pencil.

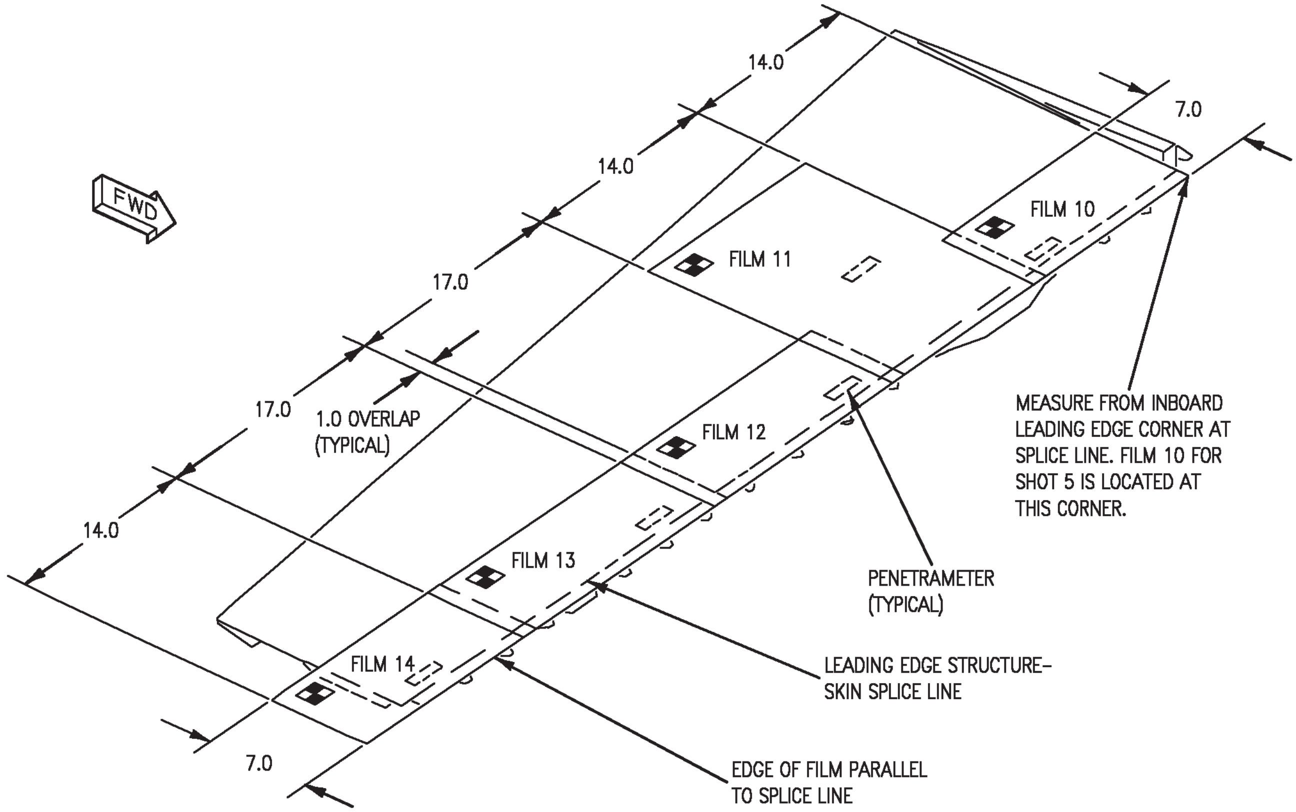
11. **SYSTEM SECURING.** Have inboard hinge fairing, 74A170624, installed (A1-F18AC-570-300, WP010 00).

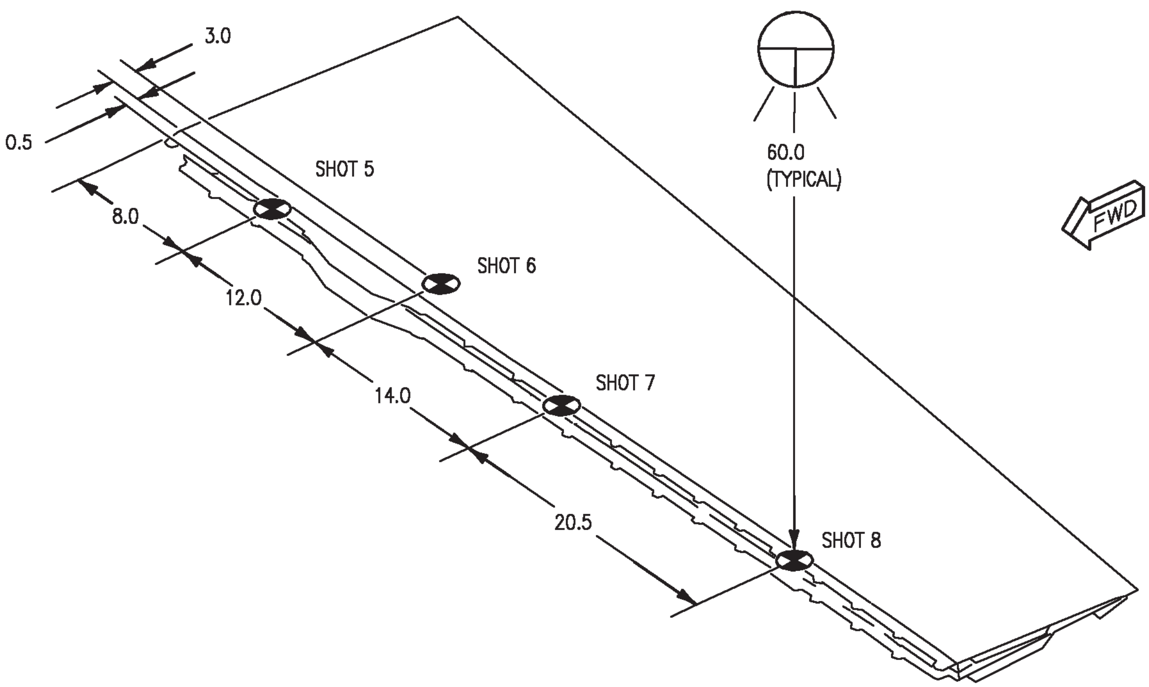




18AC-SRM-30-(93-1)30-SCAN

Figure 1. Aileron, Water in Honeycomb (Sheet 1)





18AC-SRM-30-(93-2)30-SCAN

Figure 1. Aileron, Water in Honeycomb (Sheet 2)

TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1	14 X 17	AA AND M	0.010 Pb	0.25 AL	5	40	1-1/2	1-3.5
2	14 X 17 7 X 17 2	AA AND M AA AND M	0.010 Pb	0.25 AL	5	40	1-1/2	1-3.5
3	14 X 17 7 X 17 2	AA AND M AA AND M	0.010 Pb	0.25 AL	5	40	1-1/2	1-3.5
4	14 X 17 7 X 17 2	AA AND M AA AND M	0.010 Pb	0.25 AL	5	40	1-1/2	1-3.5
5	7 X 14 2	AA AND M	0.010 Pb	0.37 AL	5	70	1	1-3.5
6	14 X 17	AA AND M	0.010 Pb	0.37 AL	5	70	1	1-3.5
7	7 X 17 2	AA AND M	0.010 Pb	0.37 AL	5	70	1	1-3.5
8	7 X 17 2 7 X 14 2	AA AND M AA AND M	0.010 Pb	0.37 AL	5	70	1	1-3.5

LEGEND

1 H AND D DENSITY UNITS.

2 USE CUT AND BAGGED 14 X 17 INCH FILM.

18AC-SRM-30-(93-3)34-SCAN

Figure 1. Aileron, Water in Honeycomb (Sheet 3)

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

AILERON DRIVE HINGE CRACKS

PART NO. 74A170604

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Integrated Flight Controls	A1-F18AC-570-300
Aileron and Aileron Shroud	WP010 00
Aileron Servocylinder (84A-U019 or 84A-V020)	WP011 00
Plane Captain Manual	A1-F18AC-PCM-000
Line Maintenance Access Doors	A1-F18AC-LMM-010
Structure Repair, General Information	A1-F18AC-SRM-200
Fasteners	WP004 06

Alphabetical Index

Record of Applicable Technical Directives

None

1. **AILERON DRIVE HINGE.** See figure 1.

2. Aileron drive hinge, drive hinge, is 7075 aluminum hand forging heat treated to -T73652. Finish system is IVD coating, one coat epoxy primer, two coats polyurethane enamel.

3. **DEFECTS.** Inspect drive hinge for cracks in inspection area (s).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.**

a. Have Door 159 L/R opened A1-F18AC-LMM-010).

b. Have fairing assembly, 74A170760, removed (A1-F18AC-570-300, WP010 00).

c. Have aileron servocylinder, 84A-U019 or 84A-V020, detached from drive hinge attach point (A1-F18AC-570-300, WP011 00).

d. Have four MS20470AD5 rivets removed from aileron support brackets (A1-F18AC-SRM-200, WP004 06). Keep 74A170644 fairing support brackets from 74A170604 aileron rib assembly.

e. Have aileron wing fold interloc lug removed (A1-F18AC-570-300, WP010 00).

NOTE

Any impedance plane eddy current equipment may be used for this procedure and any probe if equipment and probe are standard similar to para 8. In addition, alternate probes may be used with NDT-25N if they are standardized using paragraph 8. Exact equipment settings may vary.

Referance standard is considered equivalent for surface inspections if it is of same base material and contains at least two EDM notches between 0.008 and 0.040 deep.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N, MXU-713/E	Programmable Eddy-scope, Nortic
9505955	NDT-25N Accessory Kit
1RR90F-6-1/2 or Equivalent	Right Angle Surface Probe, Ferrite, Shielded Drop Probe, 1/8-Dia., 90 Degree, 200 KHz, 6 Inches, 1/2-Inch Drop, G.K. Engineering
1R90F-6-1/8 or Equivalent	Right Angle Surface Probe, Ferrite Shielded Drop Probe, 1/8-Dia., 90 Degree, 200 KHz, 6 Inches, 1/8- Inch Drop, G.K. Engineering

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
1R45F-6-1/4 or Equivalent	45 Degree Angle Surface Probe, Ferrite Shielded Drop Probe, 1/8-Dia, 45 Degree, 200 KHz, 6 Inches, 1/4-Inch Drop, G.K. Engineering
57A2271	Microdot to BNC Connecting Cables (Two Reqd)
SH-7075-17 or Equivalent	Aluminum Notched Reference Standard, G.K. Engineering

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
MIL-C-87962, TYPE 1	Cleaning Cloth
M83953-1 or -2	Pencil, Aircraft Marking

8. **Preparation of Part.**

a. Visually scan inspection area(s) for cracks. Areas cracked may show accumulation of dirt or soot.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

b. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

c. Allow to air dry for 15 minutes after cleaning.

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using eddy current equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores (A1-F18AC-PCM-000).

9. **Equipment Settings/Standardization/Setup.**

a. Connect ADN-B1 adapter, which is part of NDT-25N accessory kit, to probe connector on programmable eddy scope (tester).

b. Attach one microdot to BCN connecting cable to front of ADN-B1 adapter.

c. Attach one microdot to BNC connecting cable to side of ADN-B1 adapter.

d. Connect one probe being used for inspection, to BNC connecting cable attached to front of ADN-B1 adapter.

NOTE

Probe connected to side of adapter is used as reference coil and must be kept away from electrically conductive material.

e. Connect other probe being used for inspection to BNC connecting cable attached to side of ADN-B1 adapter.

f. Turn tester ON, depress ON button.

g. Set front face settings as below:

POWER	ON
STATUS LIGHTS	ON
GAIN	30
FREQ	190
FILTER	0
H SENS	0.5
V SENS	0.2
DISPLAY	H/V
I/O SWITCHES	OFF
ALARM	OFF
NON-STORE	OFF

h. Position probe on reference standard so probe end shaft is perpendicular to reference standard. See figure 2.

i. Press NULL and ERASE buttons.

j. Press POS button and then directional arrow on button, until dot is centered on CRT.

k. Press NULL and ERASE buttons in succession, see figure 3, CRT 1. On following steps, press ERASE button, as required.

l. Adjust ANGLE, as required, to receive a trace on CRT similar to trace shown in figure 3, CRT 2, as probe is lifted off surface of reference standard.

m. Scan probe over EDM notches of reference standard. Traces should appear on CRT similar to those in figure 3, CRT 3. If traces are not similar, adjust GAIN and ANGLE until traces are similar.

n. Press NULL after any changes to GAIN. Tester is now standardized.

10. **Inspection Procedure.** Inspection shall be done on both sides of aircraft.

a. Position probe on flat surface of inspection area. Use either 1/2 or 1/8-inch drop or 45 degree 1/4-inch drop probe, as space allows, restandardize and null, as required.

b. Press NULL and ERASE buttons. CRT should appear as shown in figure 4, CRT 1.

c. Lift probe off drive hinge to determine lift off direction.

d. Adjust ANGLE, as required, to allow lift off travel from center of CRT to left as shown in figure 4, CRT 2.

NOTE

Due to variations in conductivity from part-to-part or reference standard-to-reference standard, trace direction may rotate slightly.

- Less conductive parts, than reference standard, will have traces rotated counter clockwise.
- More conductive parts, than reference standard, will have traces rotated slightly clockwise. See traces shown in figures 3 and 4.
- Rocking probe will make trace similar to those in figure 4, CRT 3.
- Keep probe as near perpendicular to surface as possible during scanning.

e. Press NULL and ERASE, as required, to keep CRT display similar to CRT displays shown in figure 4, CRT 3, during scanning. It is acceptable for dot on CRT to travel along lift off line, long as it stays within 2 major divisions of center on CRT. Rescan any area where cursor has left CRT, Be careful to keep contact between probe tip and part, and minimize probe rocking.

f. When scanning flat surfaces, any traces on CRT displaying separation angle from lift off, greater than smallest notch depth on reference standard, see figure 3, CRT 3, shall be marked on part with aircraft marking pencil, if indication is repeatable.

g. When scanning radii, of inspection area (s), NULL position will move to below NULL position for a flat surface, refer to step h. Any crack indication (s) displayed in radii are similar to notch indications, see figure 3, CRT 3, and will emanate from lower NULL position or from points along line between two NULL positions.

h. Mark all crack indication (s) displayed with aircraft marking pencil, if indication (s) is repeatable.

i. Determine crack length by finding ends of crack. Ends of crack are found by scanning back and forth perpendicular to crack while indexing along crack centerline. When dot on CRT no longer moves from center, crack end is found.

11. **Documentation of Inspection.** See figure 5.

a. If crack indications are found, map location and size on form provided, include inner or outer side designation. Give one copy of documentation sheet to local custodian and provide local MCAIR rep with second copy.

12. **SYSTEM SECURING.**

a. Have aileron wing fold interloc lug reinstalled (A1-F18AC-570-300, WP010 00).

NOTE

Vibration driving of rivets may damage drive hinge fairing or support brackets.

b. Have four MS20470AD5 rivets installed through 74A170644, fairing support brackets, and 74A170604, aileron rib assembly (A1-F18AC-SRM-200, WP004 06).

c. Have, 84A-U019 or 84A-V020, aileron servocylinder reattached to drive hinge attach point (A1-F18AC-570-300, WP011 00).

d. Have 74A170760, fairing assembly reinstalled (A1-F18AC-570-300, WP010 00).

e. Have door 159 L/R closed (A1-F18AC-LMM-010).

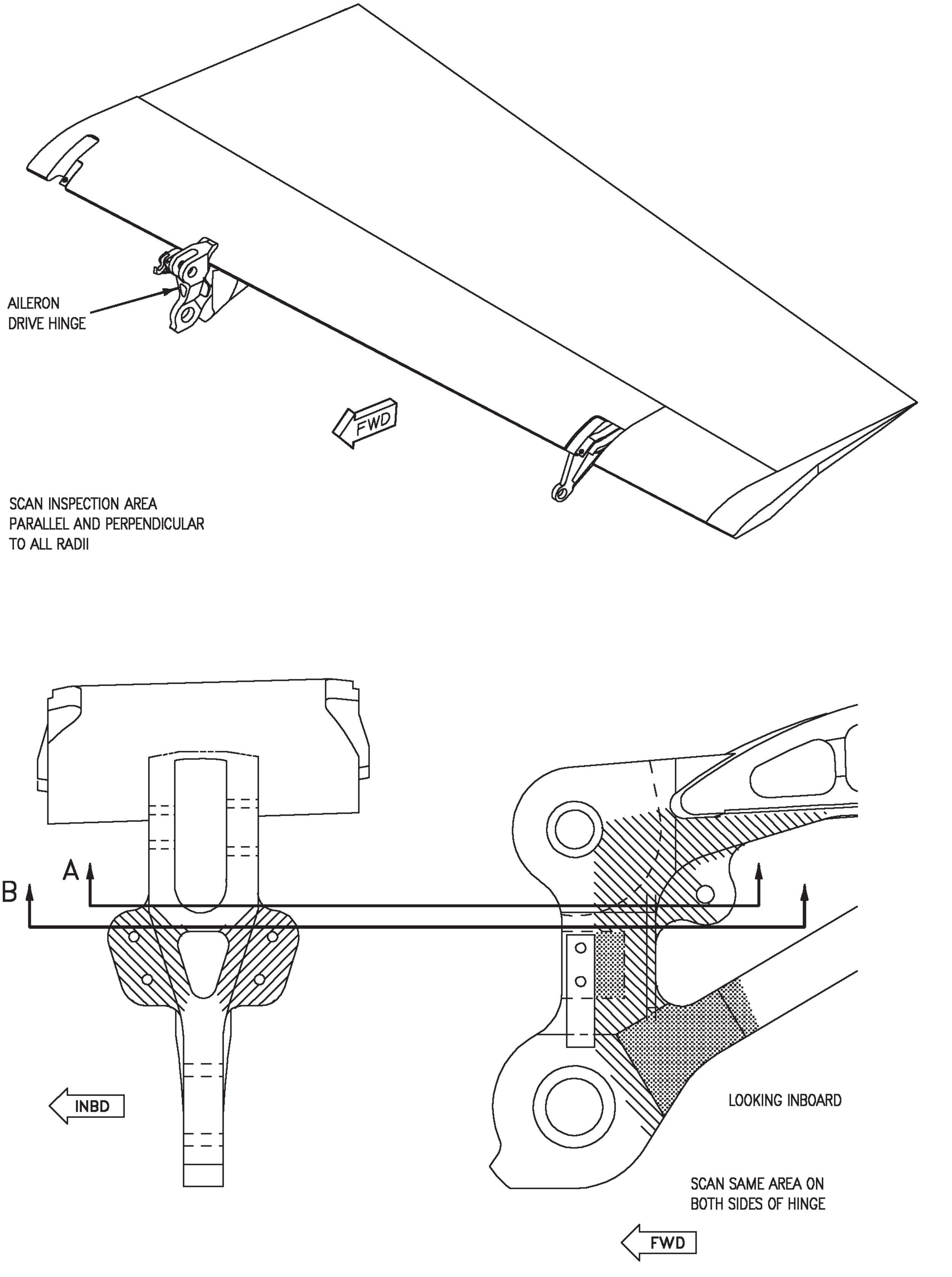


Figure 1. Inspection Area (Sheet 1)

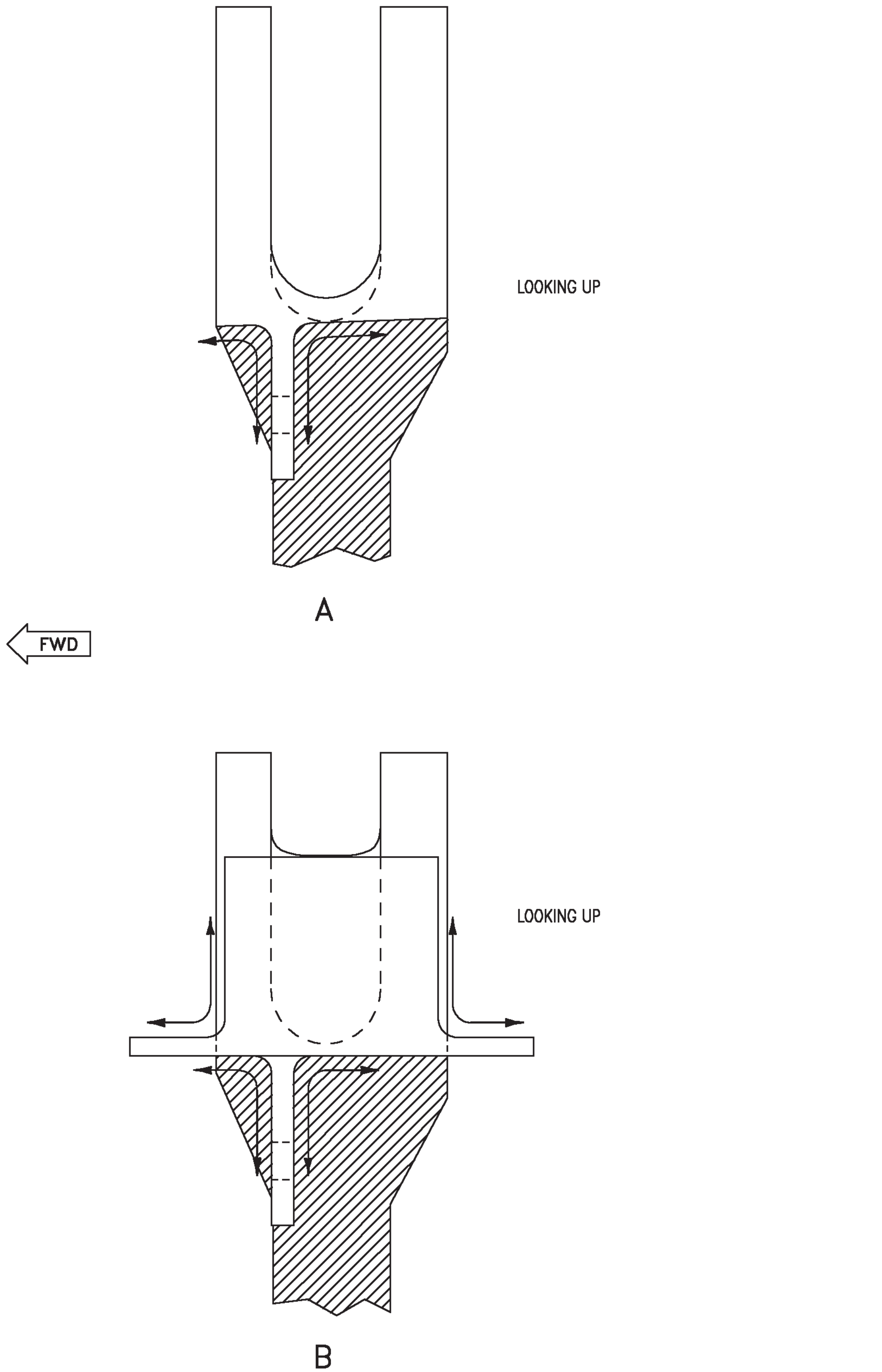


Figure 1. Inspection Area (Sheet 2)

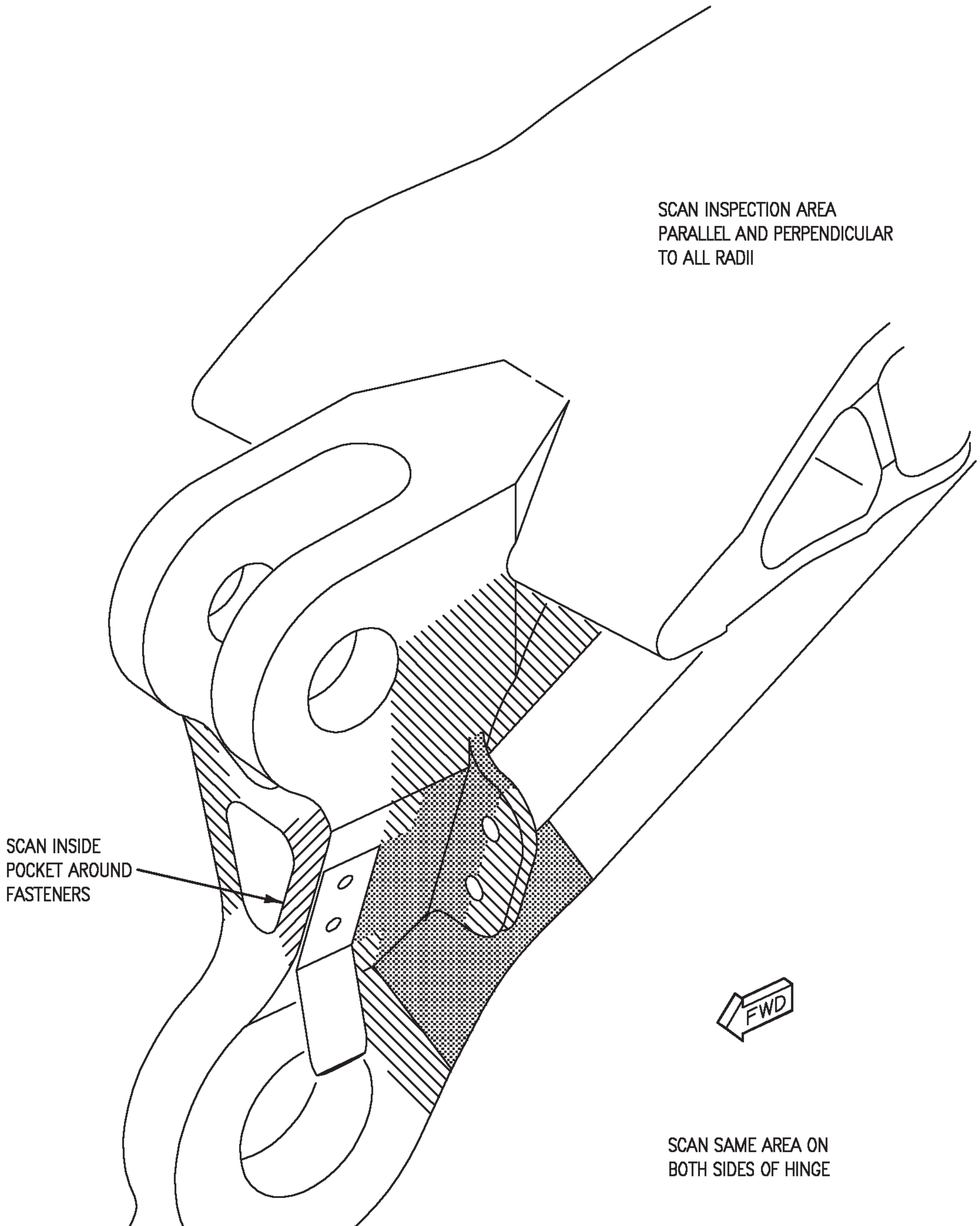


Figure 1. Inspection Area (Sheet 3)

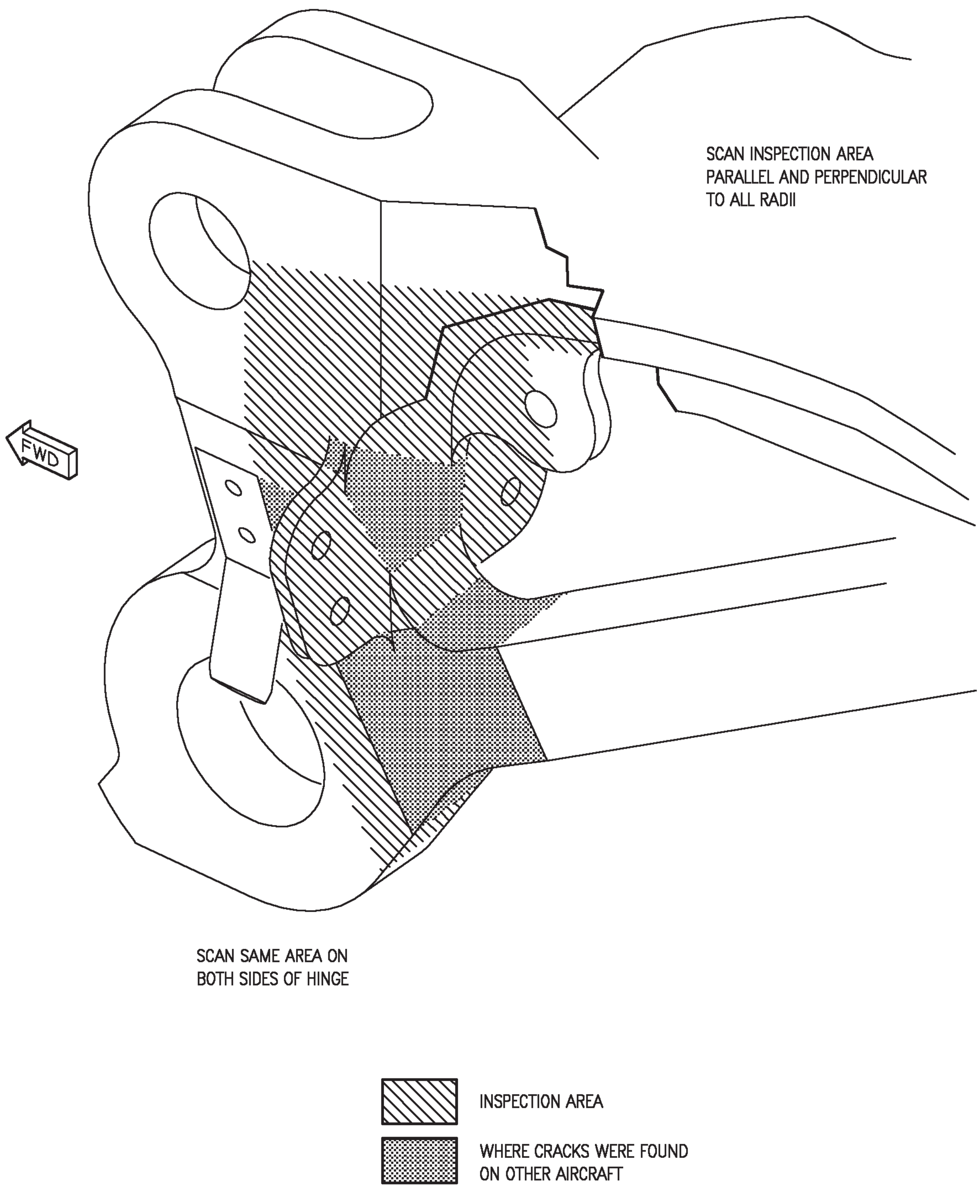
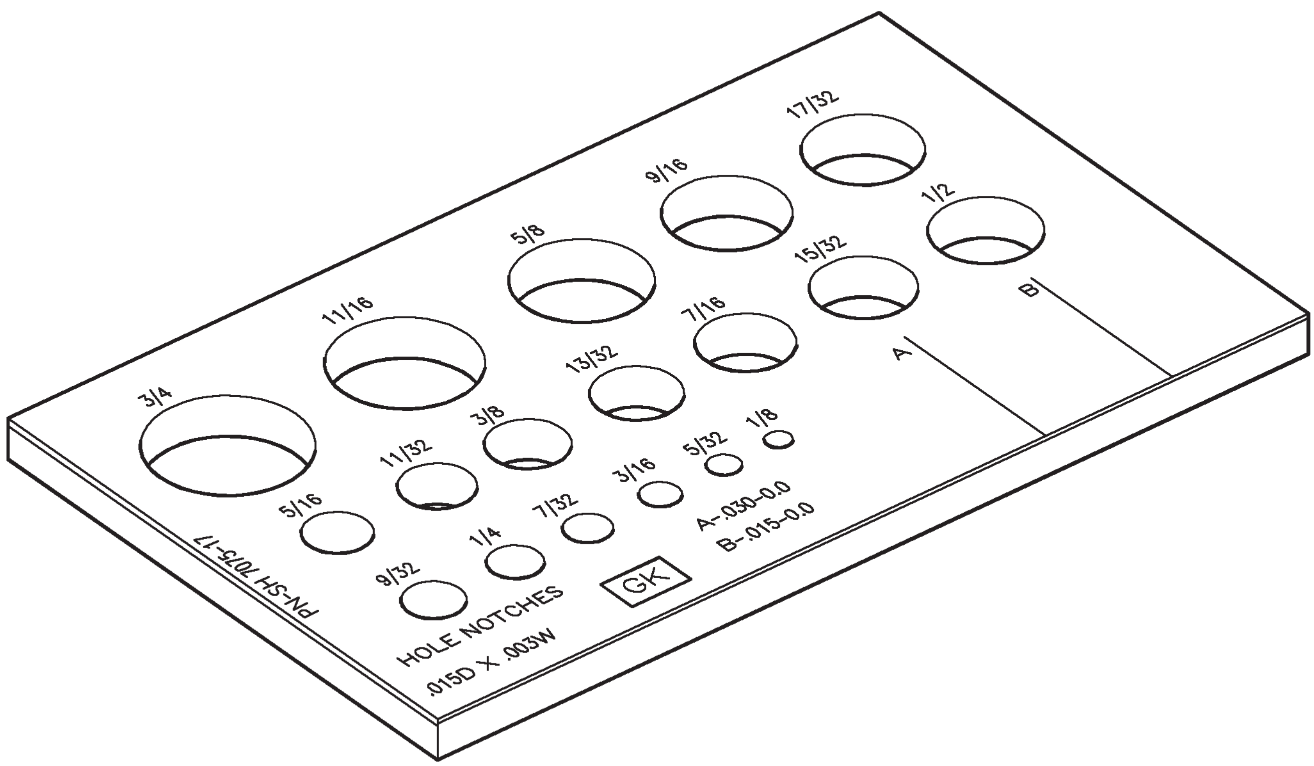


Figure 1. Inspection Area (Sheet 4)



18AC-SRM-30-(384-1)31-CATI

Figure 2. Eddy Current Reference Standard

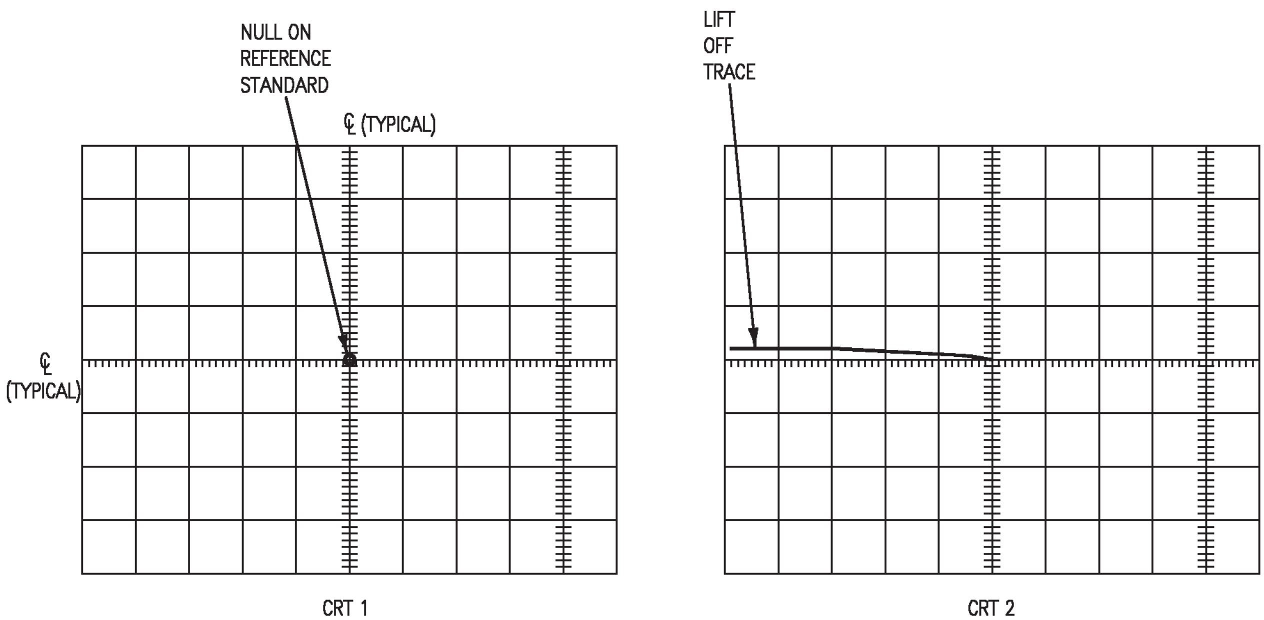
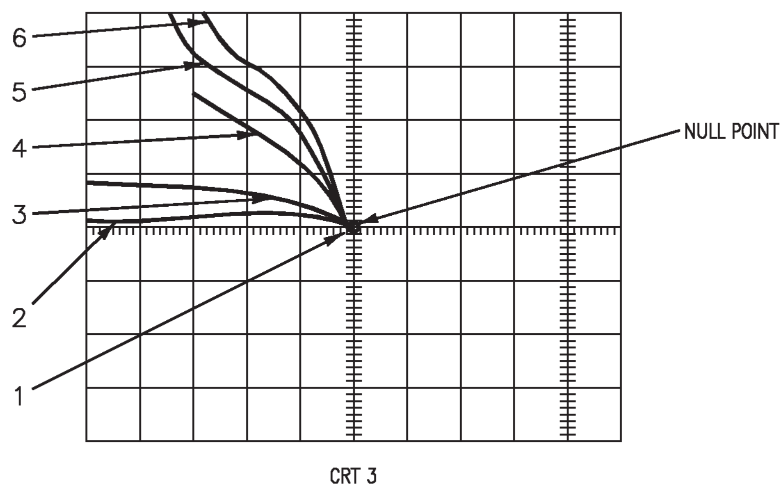


Figure 3. CRT Displays From Standardization of NDT-25N (Sheet 1)



1 POSITION PROBE AWAY FROM EDGE OR NOTCH OF REFERENCE STANDARD SURFACE. PRESS POS BUTTON AND THEN PRESS DIRECTIONAL BUTTONS, AS INDICATED BY TRIANGULAR ARROW ON BUTTON, UNTIL DOT IS IN CENTER OF CRT. PRESS NULL BUTTON THEN PRESS ERASE BUTTON.

2 LIFT OFF TRACE IS DISPLAYED WHEN PROBE IS REMOVED FROM REFERENCE STANDARD.

3 TRACE DISPLAYED BY ROCKING PROBE.

4 TRACE RESPONSE FROM 0.015 NOTCH, 1/8-INCH FROM EDGE OF STANDARD.

5 TRACE RESPONSE FROM 0.030 NOTCH, 1/8-INCH FROM EDGE OF STANDARD.

6 TRACE RESPONSE FROM EDGE OF REFERENCE STANDARD.

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Figure 3. CRT Displays From Standardization of NDT-25N (Sheet 2)

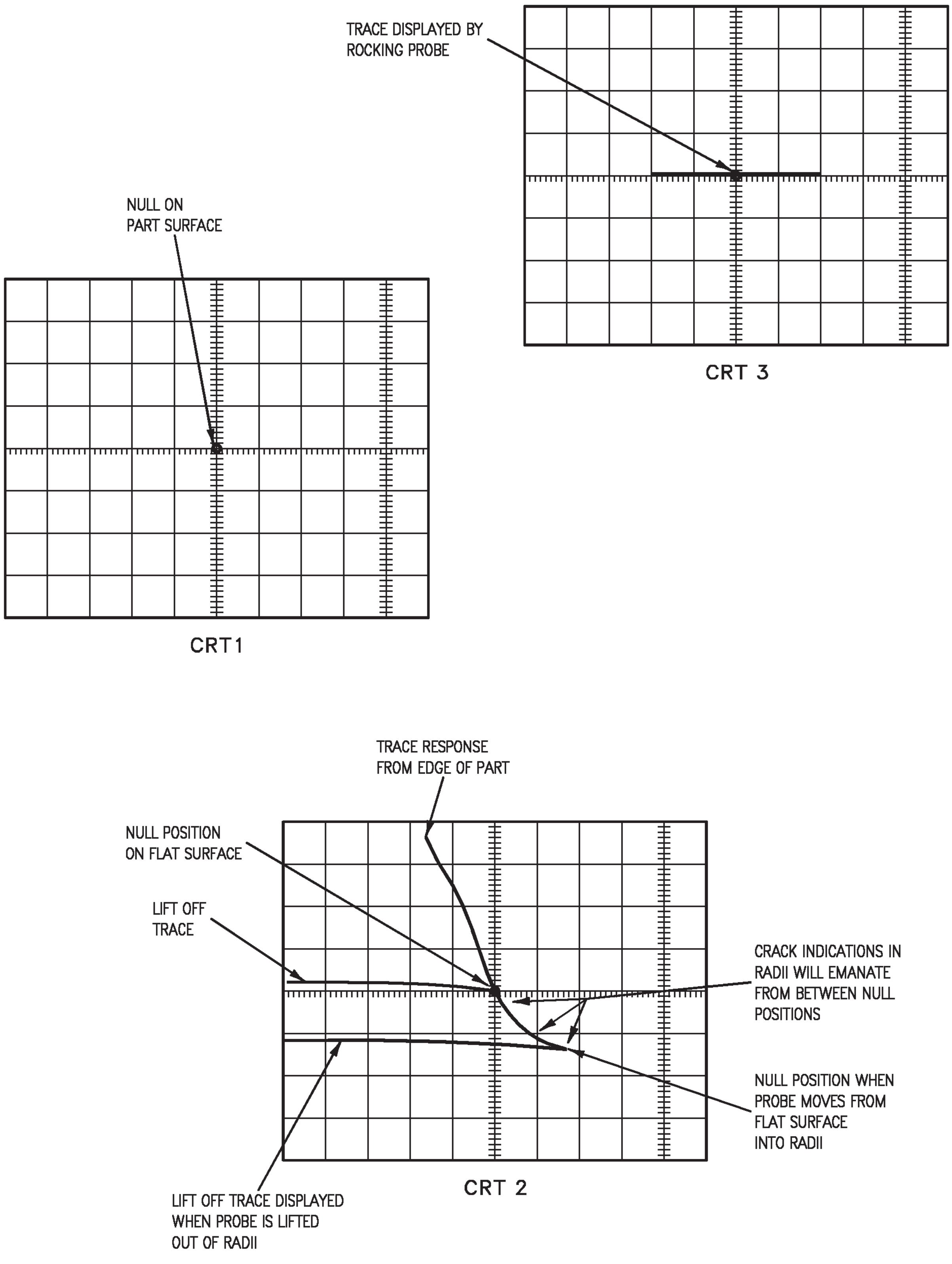
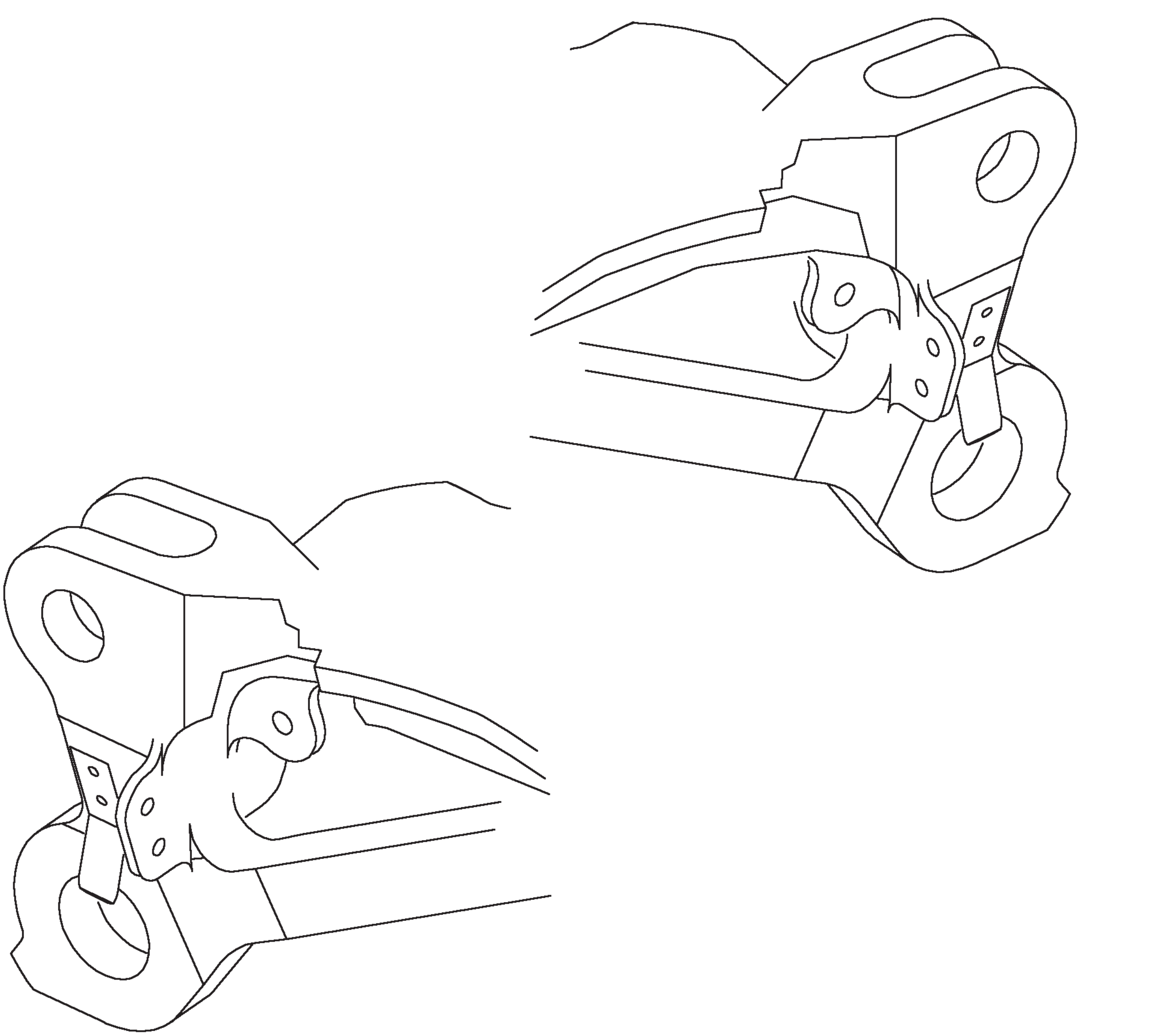


Figure 4. CRT Displays From Inspection of Aileron Drive Hinge



LOCATION

- [ ] ATSUGI
- [ ] BEAUFORT
- [ ] CECIL FIELD
- [ ] CHINA LAKE
- [ ] EL TORO
- [ ] FALLON
- [ ] IWAKUNI
- [ ] JACKSONVILLE
- [ ] KANEOHE
- [ ] LEMOORE
- [ ] NEW ORLEANS
- [ ] NORTH ISLAND
- [ ] PATUXENT RIVER
- [ ] POINT MUGU
- [ ] YUMA
- [ ] OTHER ____________________

- [ ] LH AILERON
- [ ] RH AILERON
- [ ] NO CRACK INDICATIONS FOUND

SQUADRON ____________________

BUREAU NO. ____________________

MCAIR CUM NO. ____________________

FLIGHT HOURS ____________________

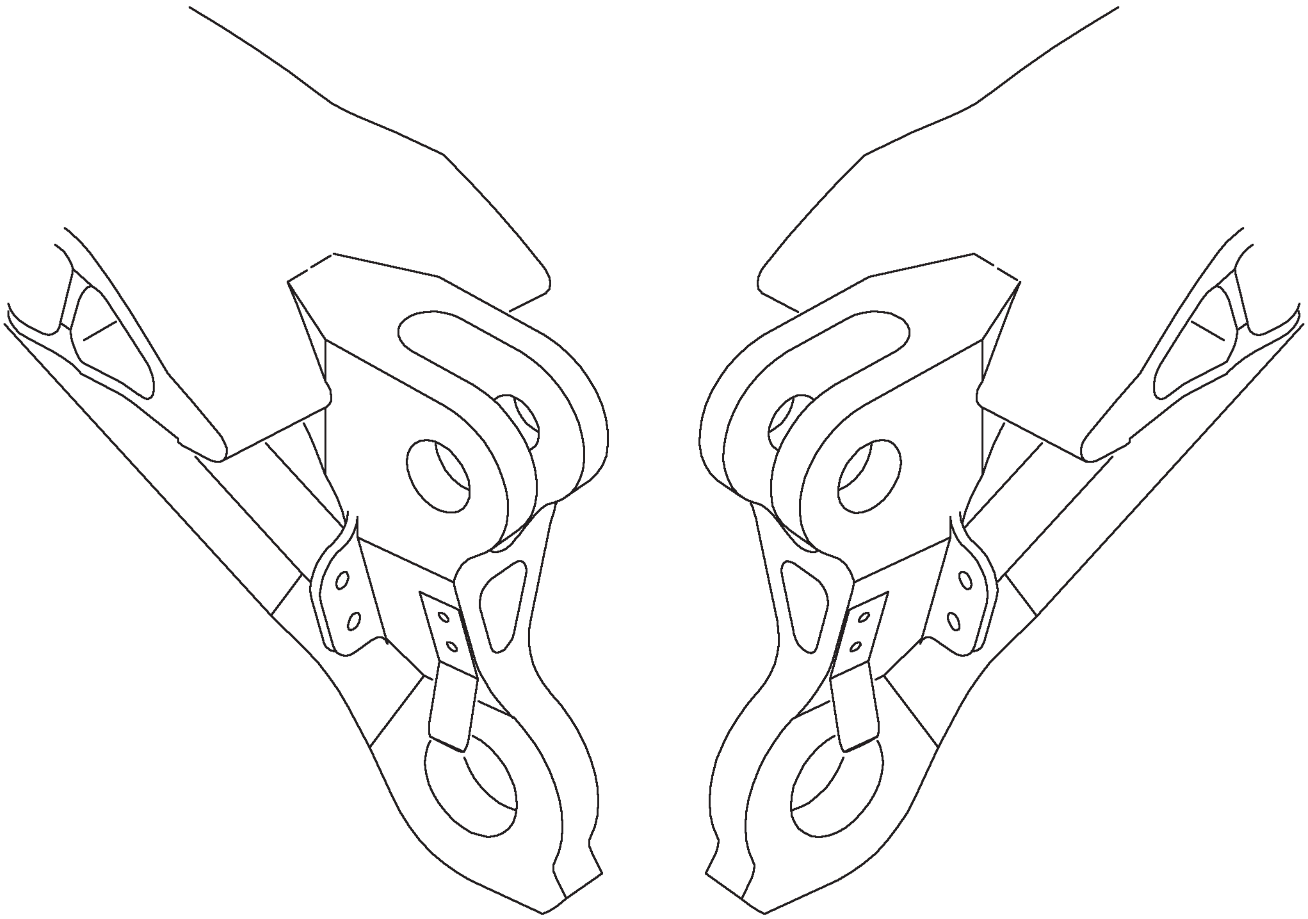
NO. OF LANDINGS ____________________

INSPECTION DATE ____________________

INSPECTOR ____________________

18AC-SRM-30-(388-1)31-CATI

Figure 5. Documentation Sheet (Sheet 1)



LOCATION

- ☐ ATSUGI
- ☐ BEAUFORT
- ☐ CECIL FIELD
- ☐ CHINA LAKE
- ☐ EL TORO
- ☐ FALLON
- ☐ IWAKUNI
- ☐ JACKSONVILLE
- ☐ KANEOHE
- ☐ LEMOORE
- ☐ NEW ORLEANS
- ☐ NORTH ISLAND
- ☐ PATUXENT RIVER
- ☐ POINT MUGU
- ☐ YUMA
- ☐ OTHER ____________________

- ☐ LH AILERON
- ☐ RH AILERON
- ☐ NO CRACK INDICATIONS FOUND

SQUADRON ____________________

BUREAU NO. ____________________

MCAIR CUM NO. ____________________

FLIGHT HOURS ____________________

NO. OF LANDINGS ____________________

INSPECTION DATE ____________________

INSPECTOR ____________________

18AC-SRM-30-(388-2)31-CATI

Figure 5. Documentation Sheet (Sheet 2)

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

AILERON OUTBOARD HINGE FLANGE

This WP supersedes WP009 02, dated 15 March 1993.

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2

Alphabetical Index

Subject **Page No.**

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No	Date Incorp	Remarks
F/A-18 AFB 243 Rev A	-	Aileron Outboard Hinge Flange Inspection	15 March 93	-

1. AILERON OUTBOARD HINGES FLANGE.

2. Aileron outboard hinge flange, see figure 1, is 6061-T6 aluminum alloy forging.

a. Part number 74A170736, Effectivity; F/A-18A/B 161353 THRU 161940 AND 161942 is IVD, aluminum coated.

b. Part number 74A170762, Effectivity; F/A-18A/B 161942, 161944 AND UP is IVD , aluminum coated. F/A-18C/D 163427 AND UP is anodized.

c. Remainder of finish system is one coat epoxy primer, and two coats polyurethane enamel.

3. **DEFECTS.** Inspect hinge flange for cracks.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044..

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have aileron put into full drooped position. Inspection area is fully accessible from top.

NOTE

Reference standard is considered equivalent for this inspection if made of same base material and contains at least two electrical discharge machined (EDM) notches between 0.008 and 0.040 inches deep.

Any impedance plane eddy current equipment may be used for this procedure along with any probe, provided equipment and probe are standardized similar to paragraph 9.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N	Programmable Eddys-scope, Nortec, MXU-713/E
9505955	NDT-25N Accessory Kit
SH-7075-17	Reference Standard
57A2271	Microdot to BNC Connecting Cable (Two Reqd)
NEC2007/F18-1	Eddy Current Surface Probe, NDT Engineering Corp.
NEC2007/F18-2	Eddy Current Surface Probe, NDT Engineering Corp.

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
M83953-1 or -2	Pencil, Aircraft Marking
CCC-C-46, TYPE I CLASS 4	Cleaning Cloth
COMMERCIAL	Scotch Tape

8. **Preparation of Part.**

a. Locate inspection area(s), see figure 2.

b. Visually inspect inspection area(s) for evidence of cracks. Cracked area(s) may show accumulation of dirt or soot.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

c. Clean inspection area(s) with cleaning compound moistened cloth to make sure inspection area(s) are free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.**

a. Attach ADN-B1 adapter, which is part of the NDT-25N accessory kit, to NDT-25N programmable eddyscope tester.

b. Attach two 57A2271 microdot to BNC connecting cables to adapter.

c. Attach surface probe being used for inspection to cable attached to front of adapter.

d. Attach other probe to cable connected to side of adapter. Probe connected to side of adapter is used as reference coil and must be kept away from electrically conductive material.

e. Set tester front face settings;

POWER	ON
STATUS LIGHTS	ON
GAIN	12
FREQ	200
ANGLE	233
FILTER	0
H SENS	1
V SENS	0.2
DISPLAY	H/V
I/O SWITCHES	OFF
ALARM	OFF

NON-STORE .... OFF

NOTE

EDM notches on reference standard are tapered. Calibration should be done over slots within 1/4 inch of edge.

f. Place one layer of tape over 0.020 EDM notch of SH-7075-17 reference standard.

g. With inspection probe held in air, press NULL.

h. Position air point, number 1, one division to right of left edge of CRT and two divisions down from top, see figure 3, CRT 1.

i. Position probe, in normal position, and in contact with taped area of reference standard, but away from EDM notch.

NOTE

Do not re-null while probe is in contact with reference standard.

j. Adjust GAIN and ANGLE to get, number 3, lift-off trace shown in figure 3, CRT 1. Dot at minimum lift-off, number 2, should be one division left of right edge of CRT and lift-off trace should start out horizontally to left. Rock probe to make sure trace end-point represents minimum lift-off.

k. With probe held in air press NULL.

l. Press ERASE.

m. Slide probe across 0.020 EDM notch and lift probe from reference standard.

n. Display should now look like, number 4, figure 3, CRT 1. Steps j. through m. may be repeated, as required, to get this trace . Keep this trace on CRT for now, it will be erased later.

10. **Inspection Procedure.**

CAUTION

Probes for this inspection are easily broken at tip. Use with care and do not force when obstruction is encountered.

a. Use figures 1 and 2 to locate inspection areas.

b. Place probe in contact with hinge flange, in normal position. Manipulate probe angle to get dot as far to right as possible on CRT, number 6, minimum lift-off. Do not re-null. Minimum lift-off point for hinge flange will be below lift-off trace for reference standard because of alloy difference and presence of coatings.

c. While holding probe against hinge flange so dot is at minimum lift-off point, decrease ANGLE by a few degrees to move dot up to lift-off trace created on reference standard.

d. Press ERASE.

e. Lift probe from hinge flange to create new lift-off trace. Dot should move to same air point as before.

f. Mark surface of CRT with aircraft marking pencil across lift-off trace, three divisions from left edge of CRT, two divisions to right of air point. This represents maximum allowable lift-off, number 5, during inspection, see figure 3, CRT 2.

g. Inspect areas of hinge flange as shown in figure 2 as areas A, B, C, and D. Slide probe across width of hinge flange. Be sure probe tip goes all the way to inner edge of hinge flange and slightly up radius. Crack is most likely to occur in hinge flange at edge of radius between flange and body of hinge. By feel and lift-off indication, one will know when probe tip starts to ride up on radius

h. While scanning, hold probe so dot stays as far to right along lift-off trace as possible.

i. Switch probes and re-standardize as required to inspect all four inspection areas on each side of aircraft.

j. If access to any part of inspection area is blocked by sealant or other obstruction, inspection

of that area shall be considered adequate if good probe contact is maintained all the way in to radius at one or more points along length of that area.

k. Any one of four inspection areas may be omitted entirely if access is restricted. For inspection area to be omitted, inspection area(s) next to it must be fully inspected.

l. Dot may travel along lift-off line due to probe wobble and paint or sealant thickness variation. This is acceptable so long as dot stays to right of maximum allowable lift-off mark on CRT. As lift-off increases, amplitude of crack indication decreases rapidly.

m. Indication from crack on flat of hinge flange will resemble trace number 6 in figure 3, CRT 3. Indication from same large crack at maximum allowable lift-off will resemble trace number 7, figure 3, CRT 3. Indication from crack at base of radius will spread as probe tip rides up radius and lift-off increases. Indication may resemble trace number 8 in figure 3, CRT 4.

n. Contacting titanium shroud track with probe will result in trace number 9 of figure 3, CRT 4.

11. **Evaluation and reporting.**

a. When reporting detected crack, location and marked estimated length of crack is required. Use skin-to-flange fasteners as points of reference. Refer to forward fastener as fastener 1.

b. Report areas not inspected and results from areas inspected. Request engineering disposition, see paragraph 10, step k.

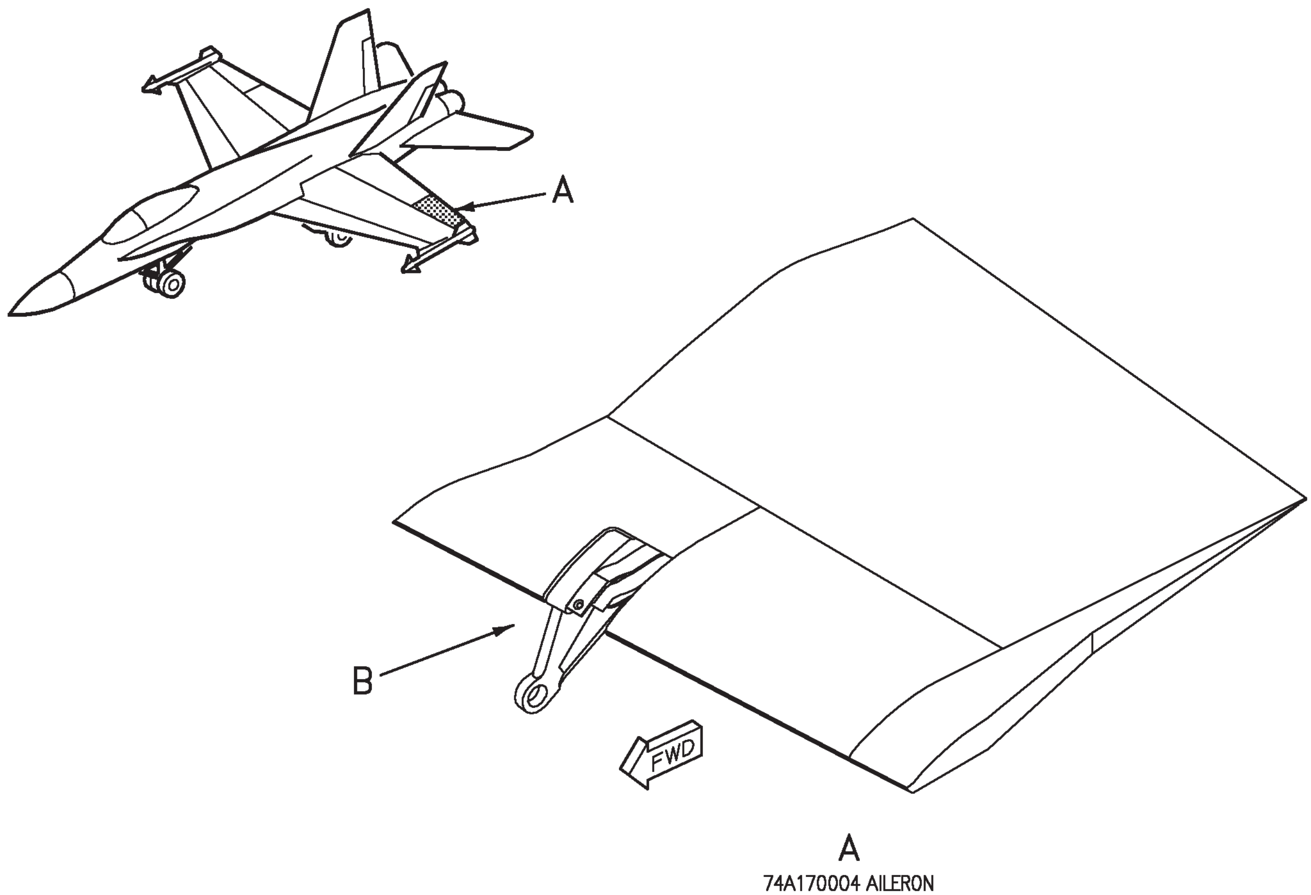
WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

12. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth.

b. Allow to air dry for 15 minutes after cleaning.



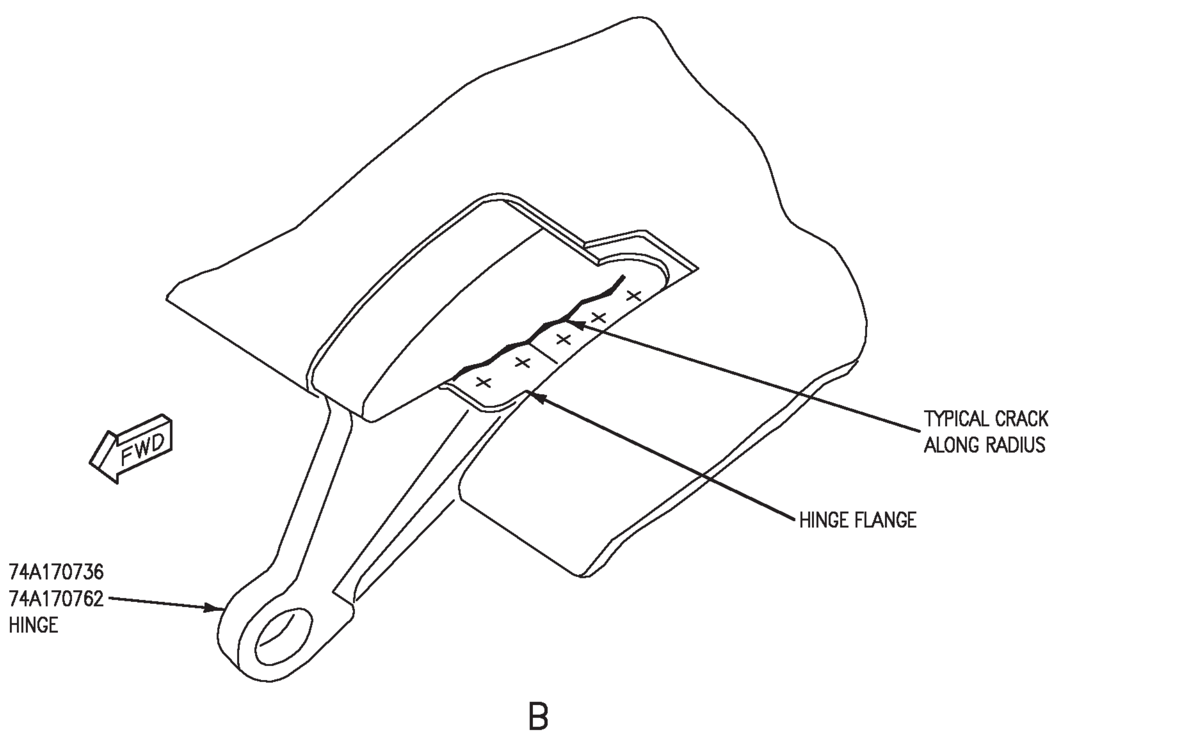


Figure 1. Crack Location

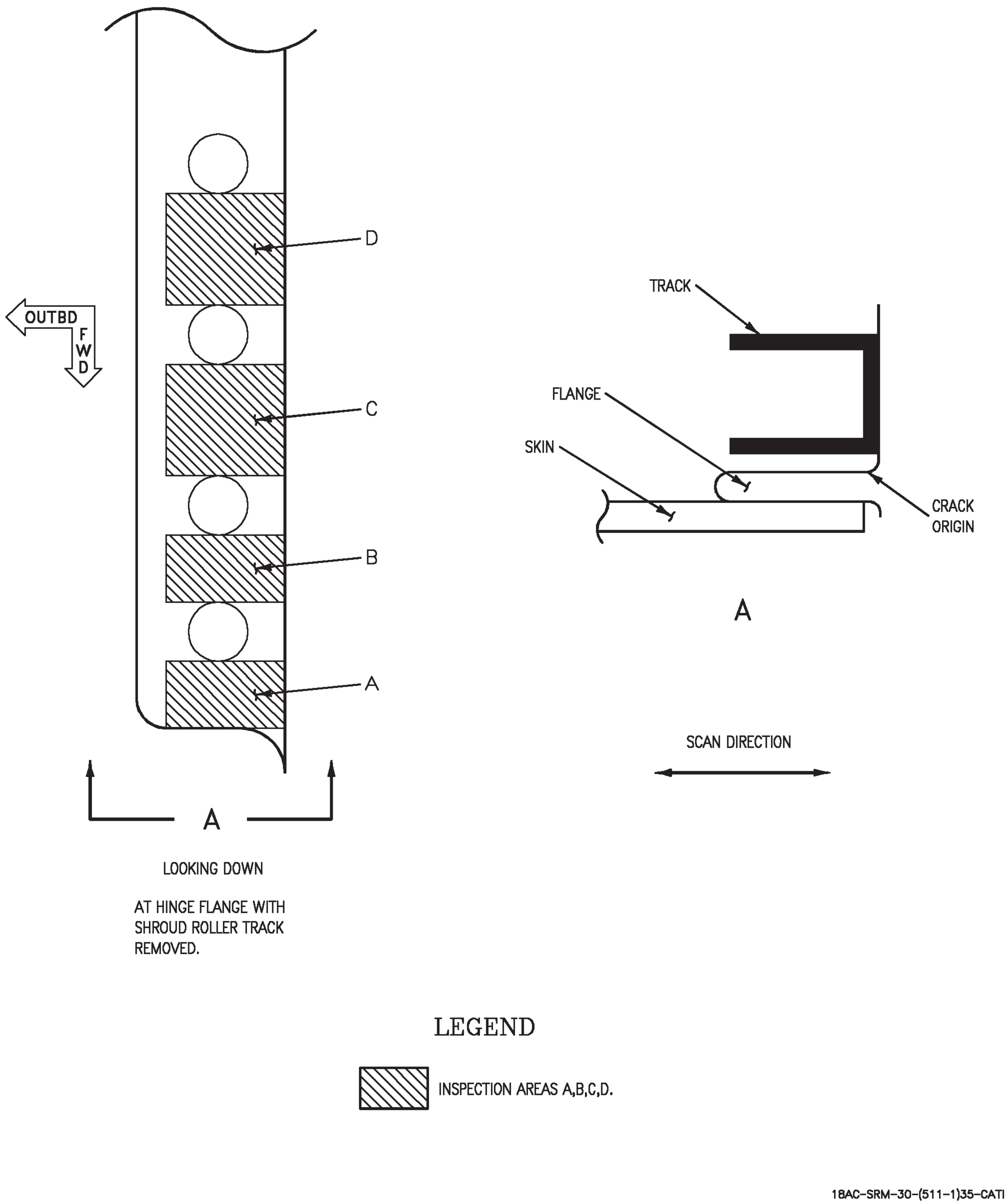


Figure 2. Inspection Areas

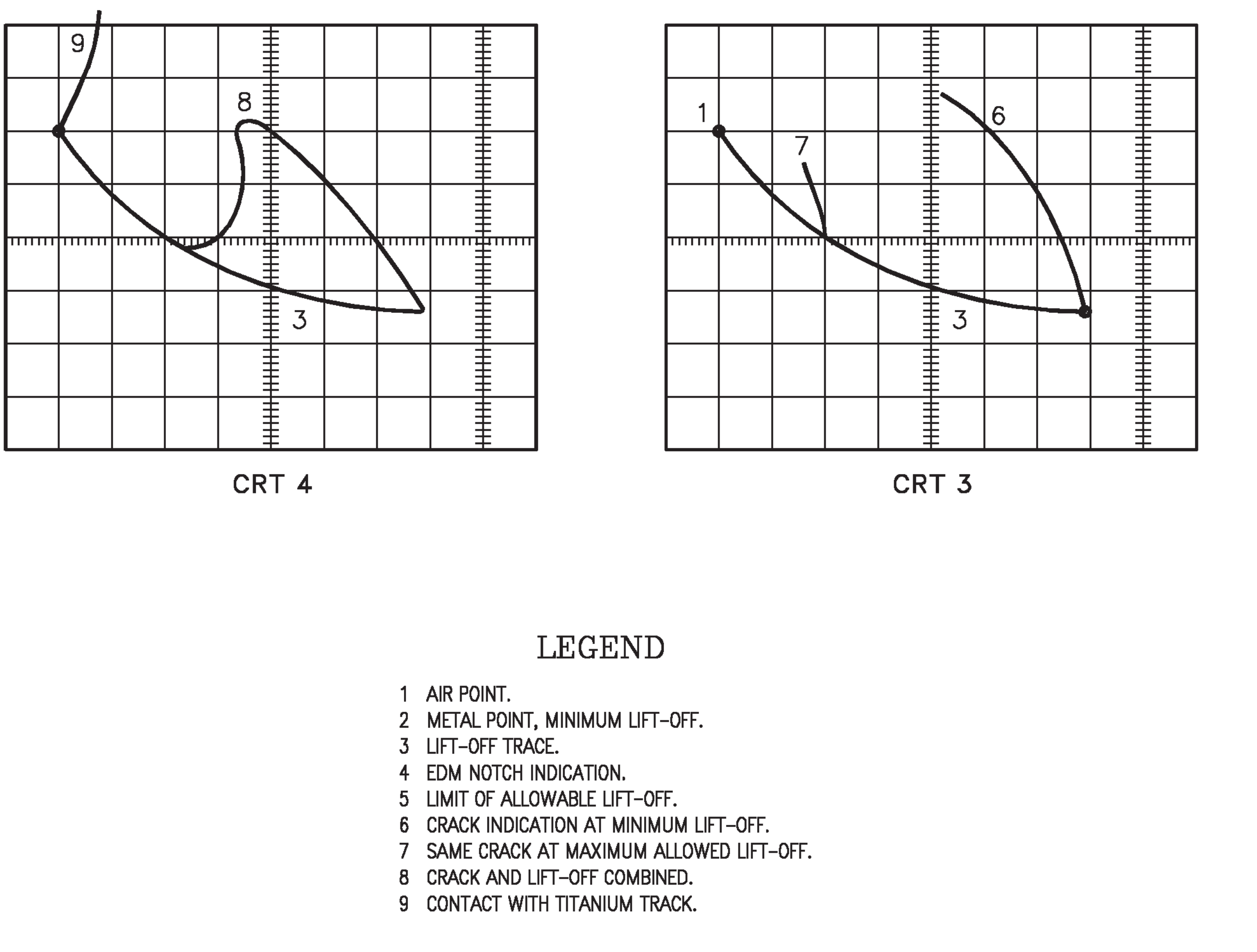


Figure 3. CRT Responses

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CANOPY UNLATCH THRUSTER SUPPORT BRACKET, F/A-18A/C

PART NO. 74A350748

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Seat, Canopy, Survival Equipment and Boarding Ladder	A1-F18AC-120-300
Canopy Unlatch Thruster (20GPK523)	WP068 00
Seat, Canopy, Survival Equipment and Boarding Ladder	A1-F18AE-120-300
Canopy Unlatch Thruster (20GPK523)	WP029 00

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No	Date Incorp	Remarks
F/A-18 (AYB) 606 Rev A	-	Canopy Unlatch Thruster Support Bracket	15 March 93	-

1. **CANOPY UNLATCH THRUSTER SUPPORT BRACKET.** See figure 1.

2. Canopy unlatch thruster support bracket, (support bracket) is machined from 7075 aluminum die forging tempered to T73 condition. Finish system is type II class I anodize, one coat epoxy primer, and two coats polyurethane enamel.

3. **DEFECTS.** Inspect for cracks on upper aft flanges, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Remove canopy unlatch thruster (A1-F18AC-120-300, WP068 00 or A1-F18AE-120-300, WP029 00).

NOTE

Reference standard is considered equivalent for surface inspections if it is same base material and contains at least two EDM notches between 0.008 and 0.040 deep.

Any impedance plane eddy current equipment may be used for this procedure in conjunction with any probe, provided equipment and probe are standardized similar to paragraph 9. In addition, alternate ferrite shielded probes may be used with NDT-25N if they are standardized in manner identical to paragraph 9. Exact tester settings may vary.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N	Programmable Eddyscope, Nortec, MXU-713/E
9505955	NDT-25N Accessory Kit
NRK-3AST	Navy Reference Standard Kit
1RR90F-10-1/2	Ferrite Shielded, 1/8 Inch Dia, 90 degree, 10 Inches Long, 190 KHz, Surface Probe
1RC45F-8-1/2	Ferrite Shielded, 1/8 Inch Dia, 45 degree, 8 Inches Long, 190 KHz, Surface Probe
57A2271	Microdot to BNC Connecting Cable (Two Reqd)

Materials Required

Specification or Part Number	Nomenclature
020 X 413	Cleaning Compound
COMMERCIAL	Tube Type Marker
CCC-C-46, TYPE I CLASS 4	Cleaning Cloth

8. **Preparation of Part.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

9. **Preparation of Part.**

a. Clean inspection area(s) with cleaning compound moistened cloth.

b. Allow to air dry for 15 minutes after cleaning.

10. **Equipment Settings/Standardization/Setup.**

a. Attach ADN-B1 adapter , which is part of the NDT-25N accessory kit, to NDT-25N programmable eddyscope (tester).

b. Attach two 57A2271 microdot to BNC connecting cables to adapter.

c. Attach probe being used for inspection to cable attached to front of adapter and other probe to cable connected to side of adapter. Cable connected to side of adapter is used as reference coil and must be kept away from electrically conductive material.

d. Set tester front face settings;

POWER	ON
STATUS LIGHTS	ON
GAIN	30
FREQ	190
FILTER	0
H SENS	0.5
V SENS	0.2
DISPLAY	H/V
I/O SWITCHES	OFF
ALARM	OFF
NON-STORE	OFF

e. Position probe on NRK-3AL reference standard, which is part of the Navy reference standard kit

f. Press NULL button and then press ERASE button.

g. Press POS button and then press directional button(s), as indicated by triangular arrow on button, until dot is centered on CRT.

h. Press ERASE button, see figure 2, CRT 1.

NOTE

On following steps press ERASE as required.

i. Adjust ANGLE, as required, to receive trace on CRT similar to trace shown on figure 2, CRT 2, as probe is lifted off surface of reference standard.

j. Scan probe over EDM notches on both sides of reference standard and over edge of reference standard. Traces should appear on CRT similar to those shown on figure 2, CRT 3. If traces are not similar, adjust GAIN and ANGLE until they are similar. Press NULL after any change(s) to gain.

11. **Inspection Procedure.**

a. Visually inspect support bracket in area shown in figure 1 for cracks using flashlight and mirror. Areas cracked may show accumulation of dirt or soot.

b. Position probe sensor on support bracket.

c. Press NULL and ERASE buttons, CRT should appear as shown on figure 3, CRT 1.

d. Lift probe off part to determine lift-off direction.

e. Adjust ANGLE, as required, to get lift-off travel from center of CRT to left as shown on figure 3, CRT 2.

f. Scan inspection area in direction shown on figure 1.

g. Index 1/16 inch scans.

NOTE

Lift-off will always trace to left. Tapered section, becoming thinner during scanning will trace downward on CRT.

h. Press ERASE, as required, to make sure flying dot stays on CRT during scanning. It is acceptable for dot on CRT to travel along lift-off line as long as it remains within 2 major divisions of center on CRT. Rescan any area in which cursor has left CRT, being careful to maintain good contact between probe tip and part, minimize rocking of probe.

i. Traces that appear on CRT, having separation angle from lift-off greater than smallest notch on reference standard, see figure 2, CRT 3, shall be marked on part with tube type marker, if indication is repeatable.

NOTE

Due to variations in conductivity from part-to part or reference standard-to-reference standard, trace direction may rotate slightly. Less conductive parts, than reference standard, will trace counterclockwise, while more conductive parts will trace slightly clockwise from those shown in figures 2 and 3.

j. Determine crack length by scanning back and forth perpendicular to crack while indexing along crack centerline.

k. When determining crack length, ends of cracks will be determined when dot returns to center position on CRT. To verify end of crack(s), scan from good area into suspect end of crack and mark area on part where dot begins to raise from centerline.

12. **Documentation.** If cracks are found, mark location and dimensions on sketch similar to figure 4. Include information such as; aircraft bureau number, total flight hours, airframe bulletin number, date of inspection, and printed name of inspector. Give one copy to local engineering for disposition, file one copy and disposition in aircraft log book, and give one copy to local MCAIR representative.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

13. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

a. Clean inspection area(s) with cleaning compound moistened cloth.

b. Allow to air dry for 15 minutes after cleaning.

14. **SYSTEM SECURING.** Have canopy unlatch thruster reinstalled (A1-F18AC-120-300, WP068 00 or A1-F18AE-120-300, WP029 00).

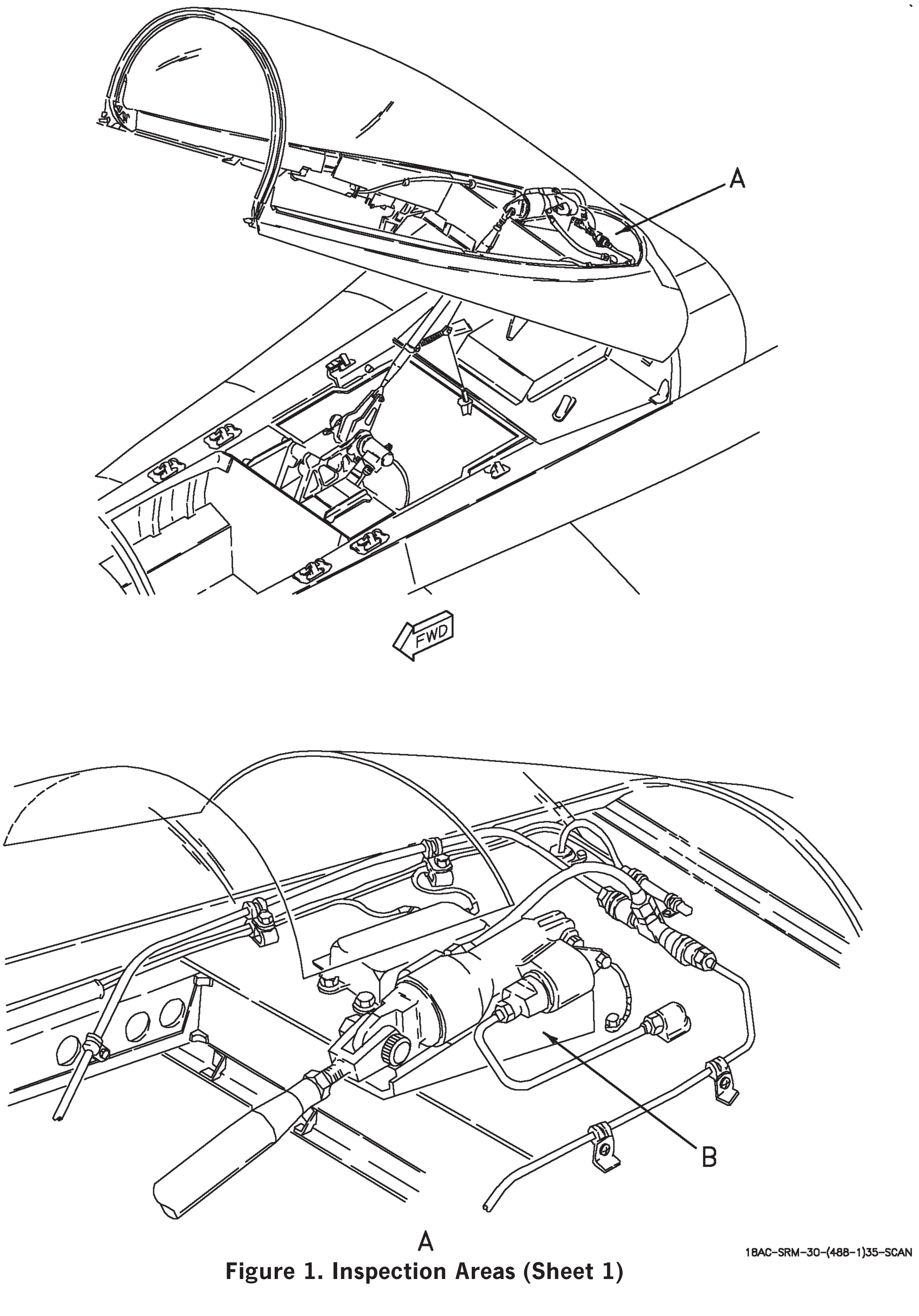


Figure 1. Inspection Areas (Sheet 1)

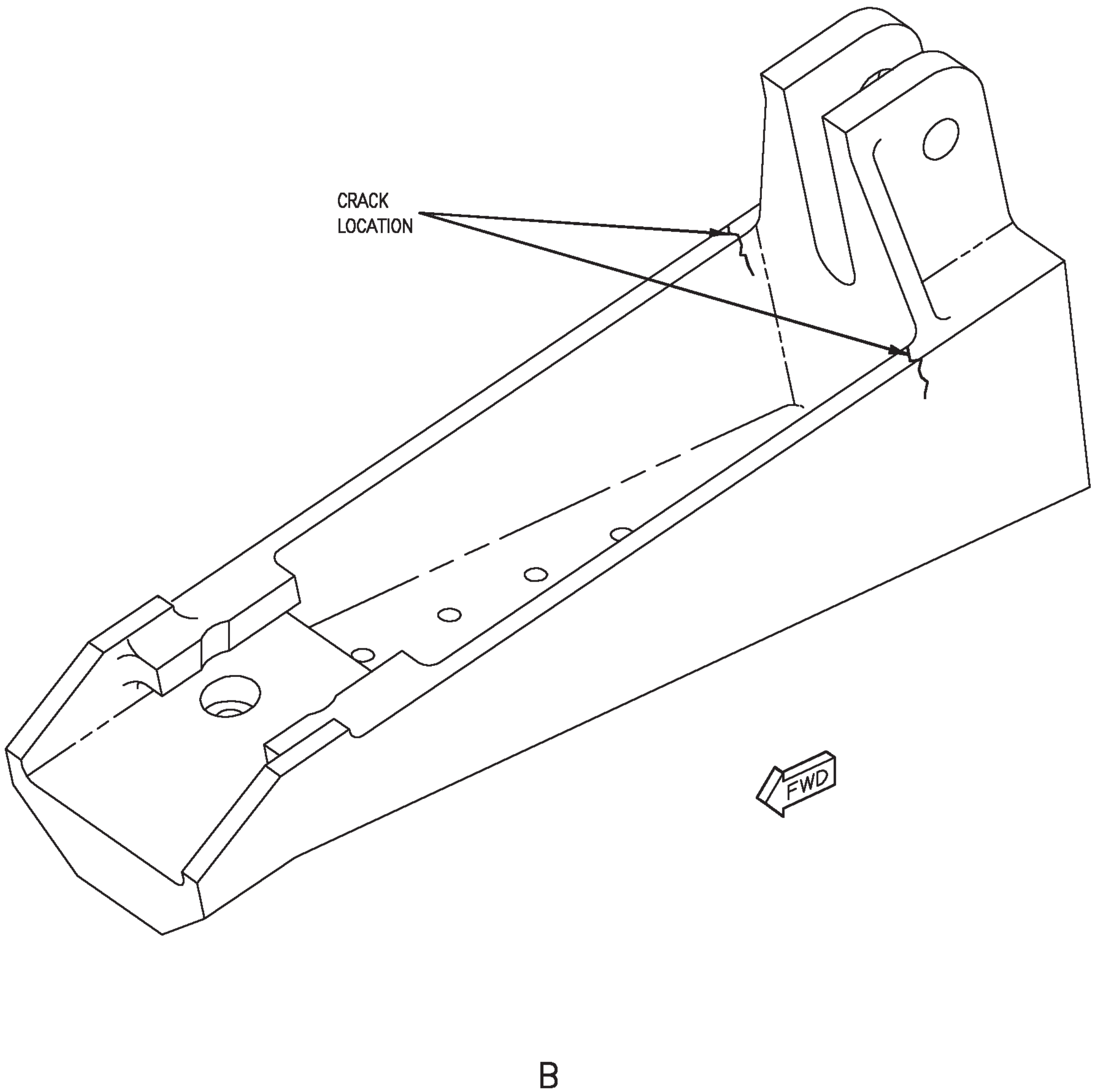


Figure 1. Inspection Areas (Sheet 2)

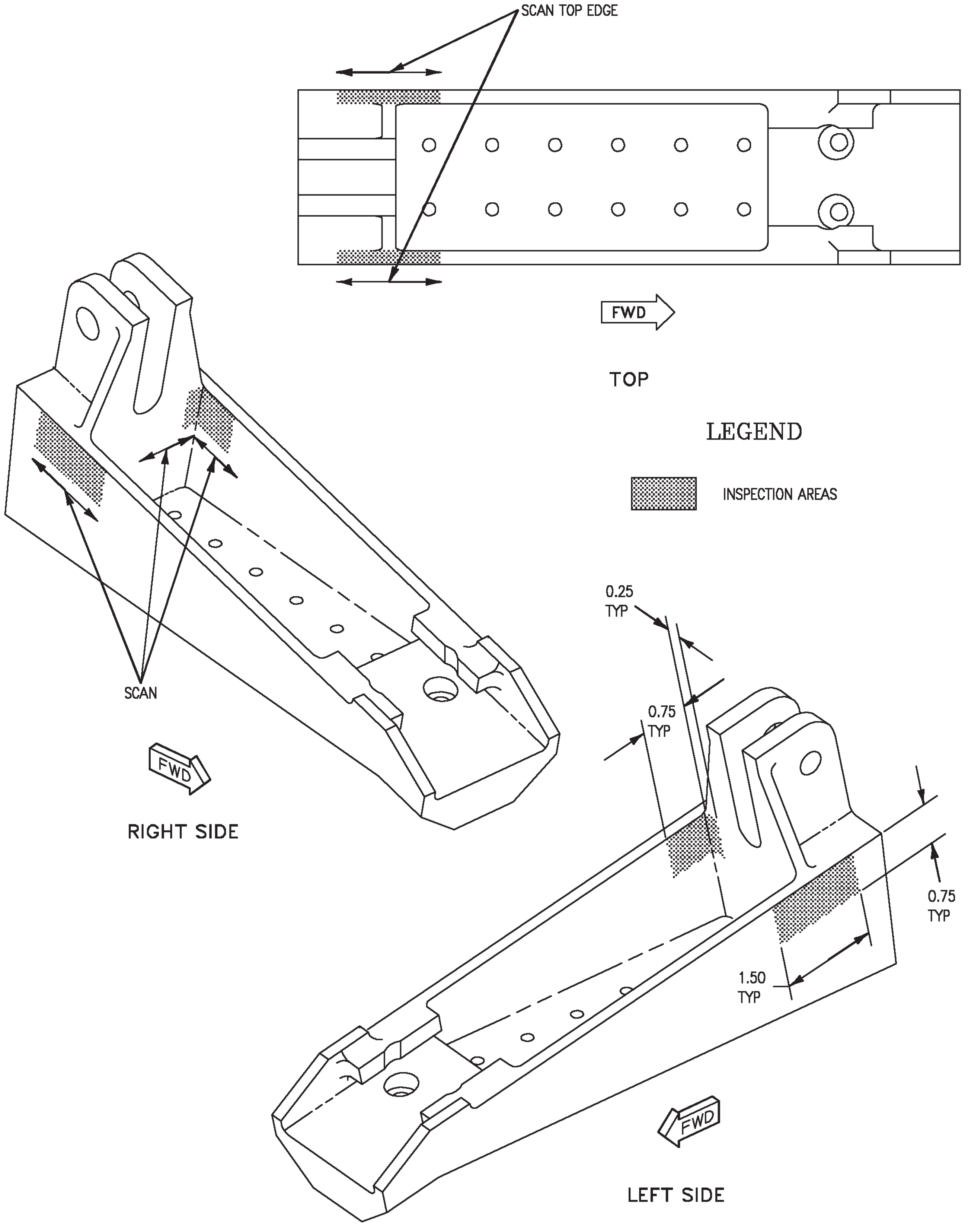
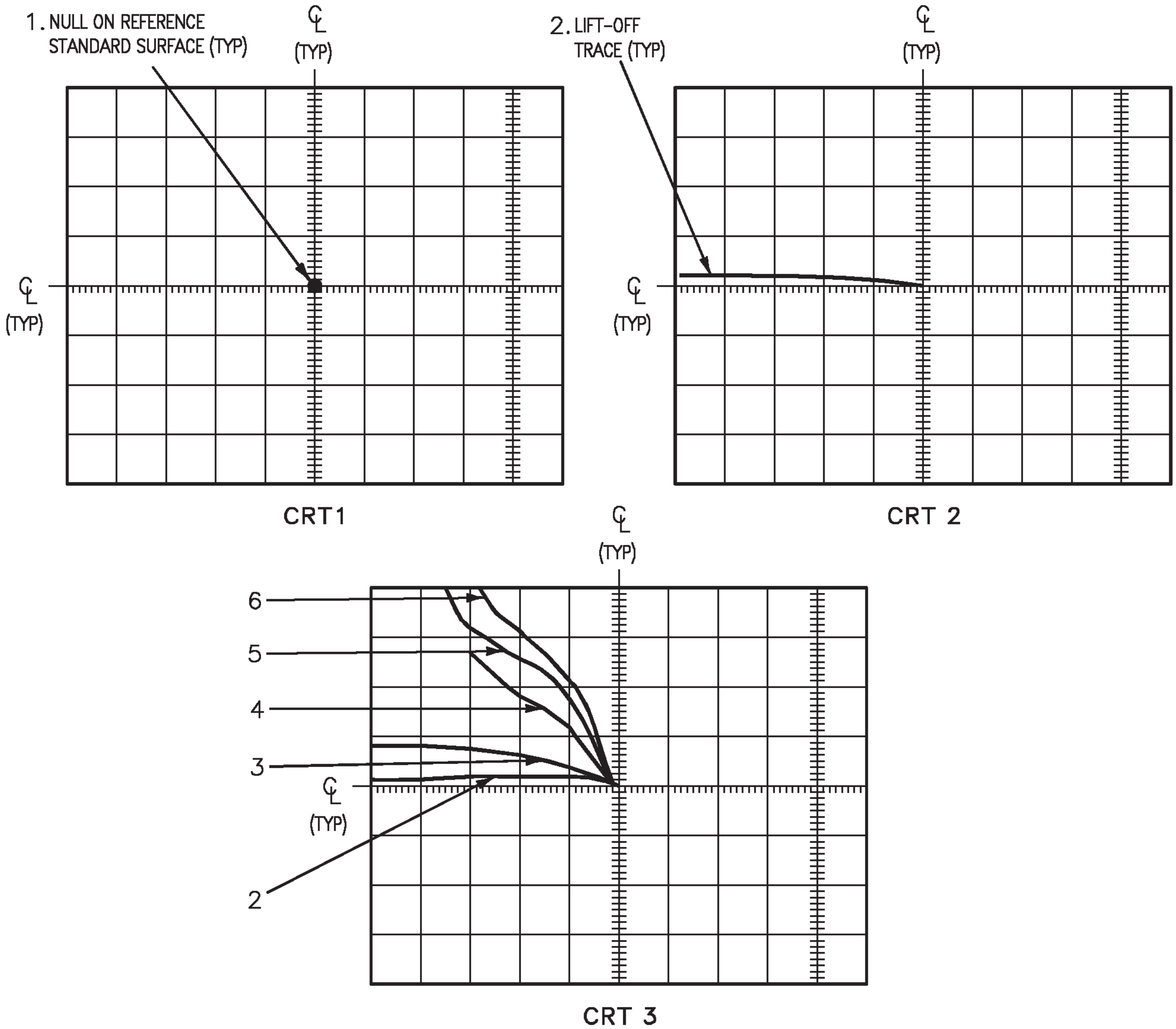


Figure 1. Inspection Areas (Sheet 3)



1. POSITION PROBE AWAY FROM EDGE OR NOTCH, NORMAL TO REFERENCE STANDARD SURFACE. PRESS POS BUTTON THEN PRESS DIRECTIONAL BUTTONS (AS INDICATED BY TRIANGULAR ARROW ON BUTTON) UNTIL DOT IS IN CENTER OF CRT. PRESS NULL BUTTON THEN ERASE BUTTON.

2. LIFT-OFF TRACE RESPONSE IS RECEIVED WHEN PROBE IS REMOVED FROM REFERENCE STANDARD.

3. TRACE RESPONSE RECEIVED WHEN ROCKING PROBE.

4. TRACE RESPONSE FROM 0.015 NOTCH, 1/8 FROM EDGE OF STANDARD.

5. TRACE RESPONSE FROM 0.030 NOTCH, 1/8 FROM EDGE OF STANDARD.

6. TRACE RESPONSE FROM EDGE OF REFERENCE STANDARD.

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Figure 2. CRT Displays From Standardization

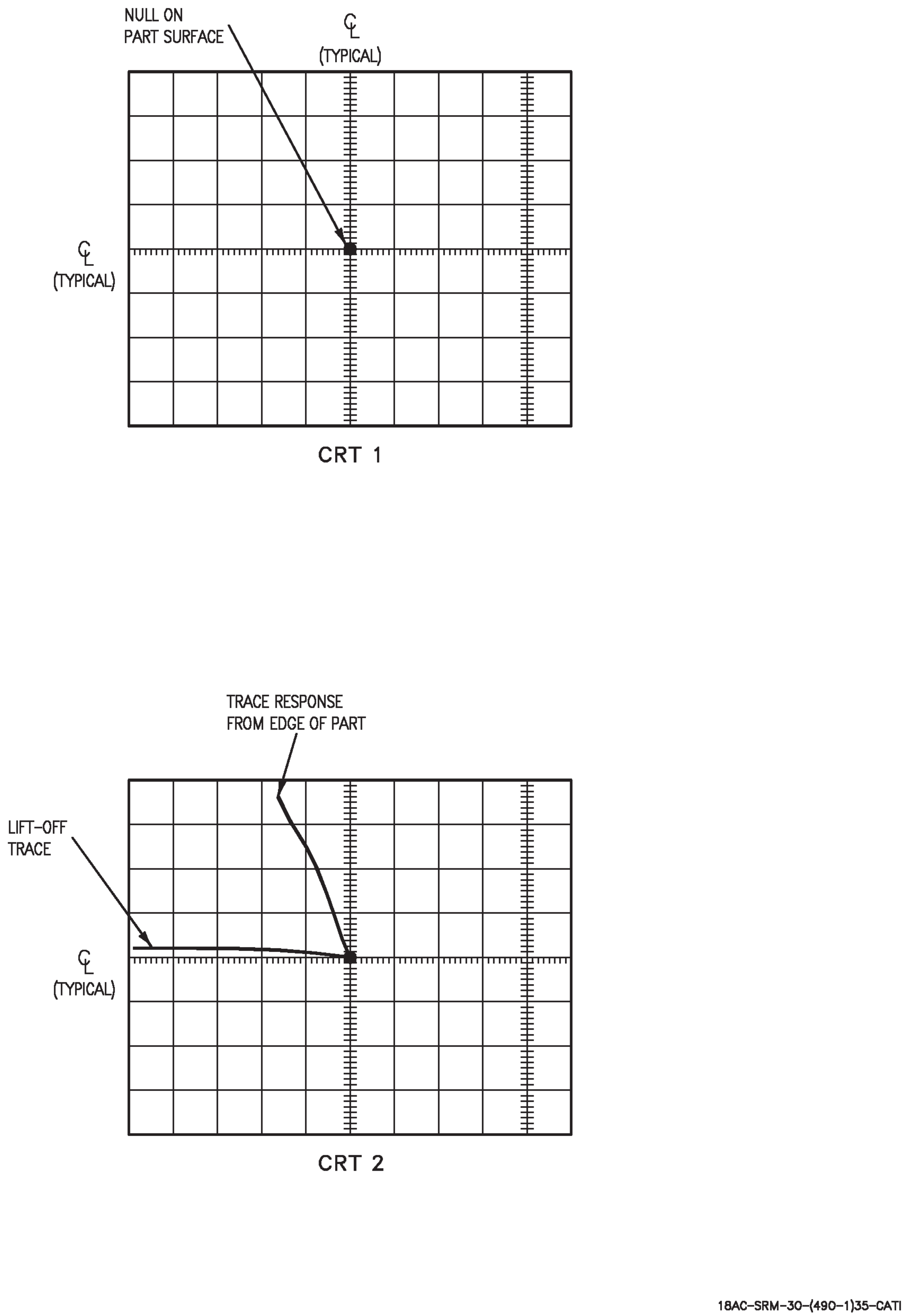
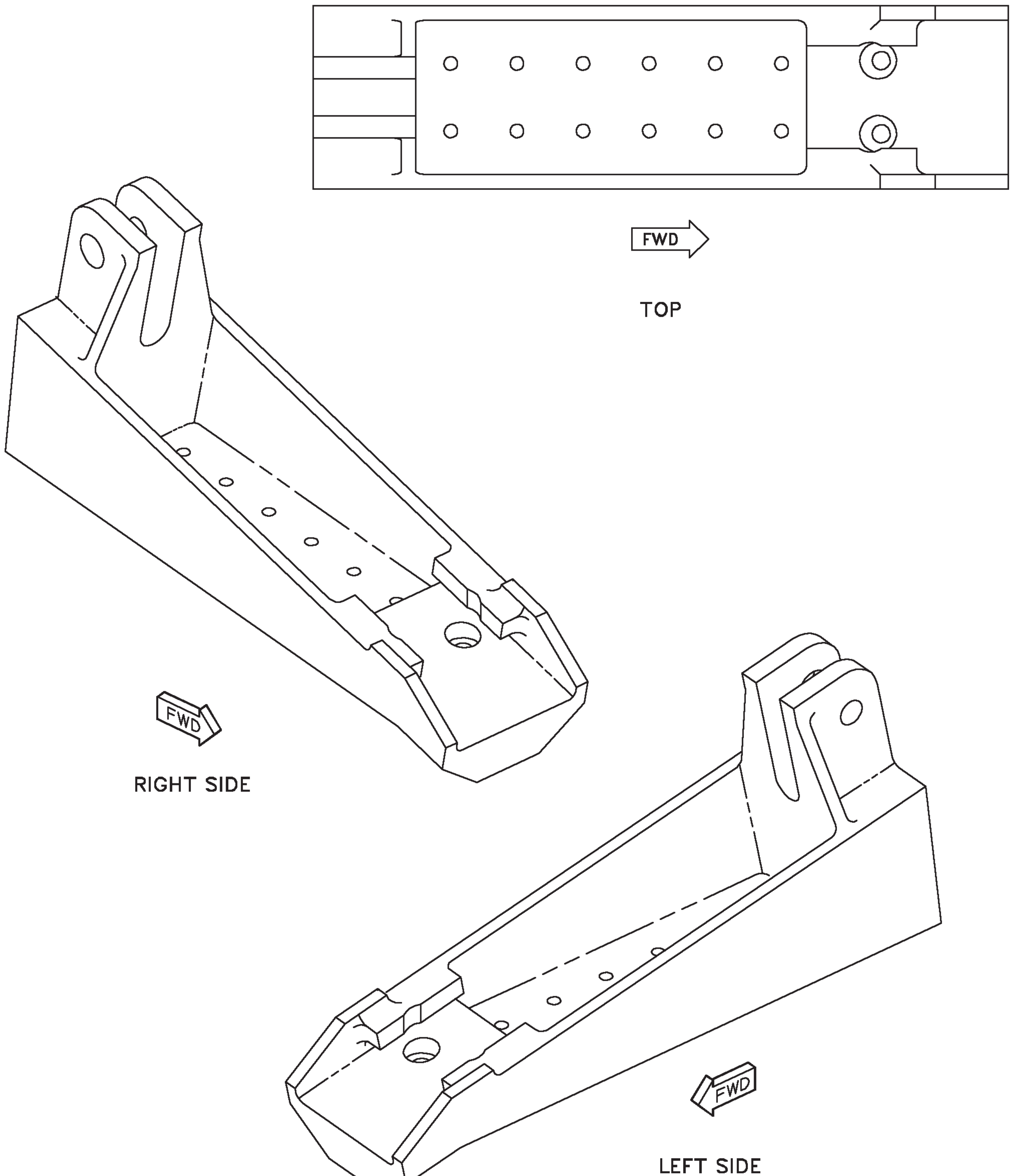


Figure 3. CRT Displays From Inspection



18AC-SRM-30-(491-1)35-CATI

Figure 4. Documentation (Sheet 1)

LOCATION

- ☐ ATSUGI
- ☐ BEAUFORT
- ☐ CECIL FIELD
- ☐ CHINA LAKE
- ☐ EL TORO
- ☐ FALLON
- ☐ IWAKUNI
- ☐ JACKSONVILLE
- ☐ KANEOHE
- ☐ LEMOORE
- ☐ NEW ORLEANS
- ☐ NORTH ISLAND
- ☐ PATUXENT RIVER
- ☐ POINT MUGU
- ☐ YUMA

- ☐ OTHER ______________________

☐ NO CRACK INDICATIONS FOUND

SQUADRON ______________________

BUREAU NO. ______________________

MCAIR CUM NO. ______________________

FLIGHT HOURS ______________________

NO. OF LANDINGS ______________________

INSPECTION DATE ______________________

INSPECTOR ______________________

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Figure 4. Documentation (Sheet 2)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

AILERON SHROUD

WATER IN HONEYCOMB

PART NO. 74A170103

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Integrated Flight Controls	A1-F18AC-570-300
Aileron and Aileron Shroud	WP010 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiographic	WP005 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **AILERON SHROUD.**

2. The aileron shroud is a bonded honeycomb assembly. Honeycomb core is 0.125 hexagonal cell, 5056 aluminum alloy. Skins are 7075 alclad and structure is 7075 aluminum alloy. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX M FILM CODE M-2 or INDUSTREX AAFILMCODE 14X17	Radiographic Film, 7 x 14
MIL-P-83953-2 TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have aileron shroud removed (A1-F18AC-570-300, WP010 00).

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per technique chart, see figure 1.

10. **Inspection Procedure.**

a. Locate films 1 and 2 for shot 1. Film should be taped to upper surface of shroud with identification markers taped to source side of film pack and penetrameters taped to source side of aileron shroud.

b. Locate source to aiming point for shot 1. Source should be normal to aiming point.

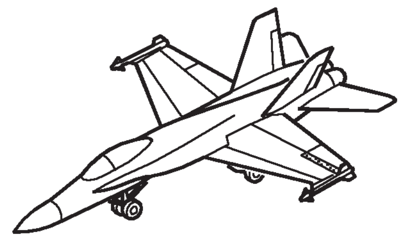
c. Expose films 1 and 2 simultaneously using technique chart settings for shot 1. Remove exposed film.

d. Repeat steps a through c for films 3 through 8 and shot 2 through 4.

e. Process exposed film. Interpret radiographs for water trapped in honeycomb core (WP005 00).

f. Mark defect(s) using aircraft marking pencil.

11. **SYSTEM SECURING.** Have good aileron shroud installed (A1-F18AC-570-300, WP010 00).



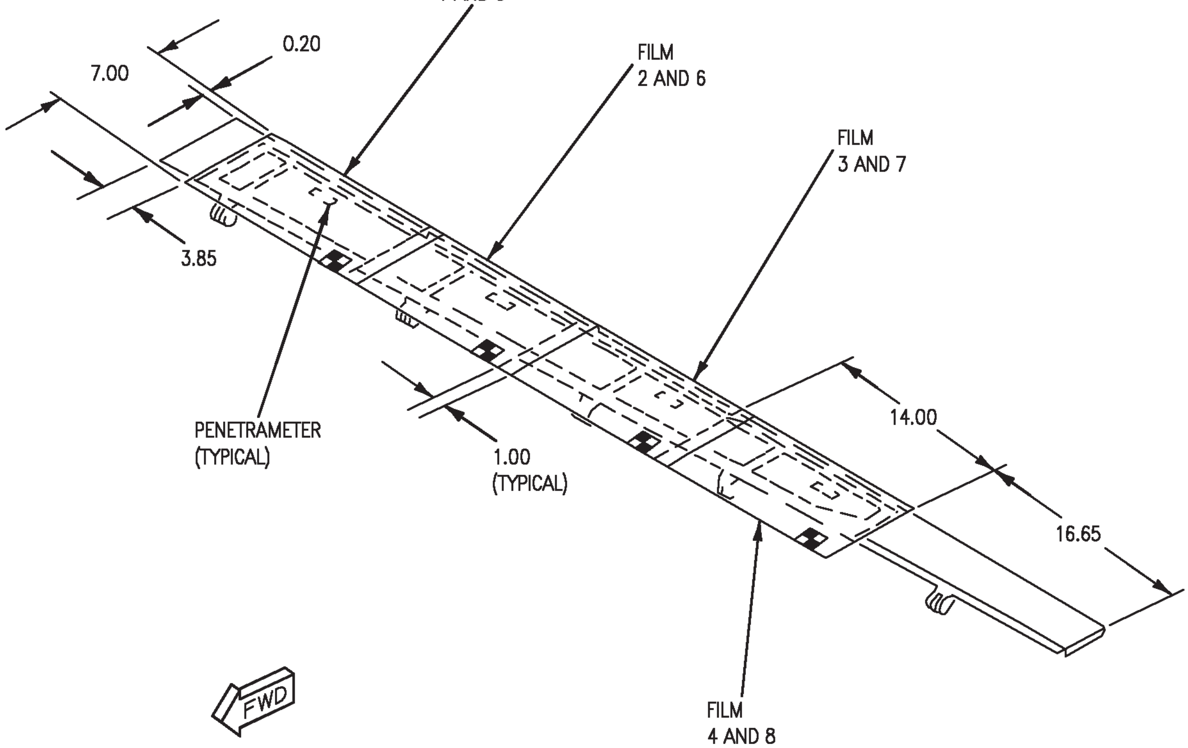
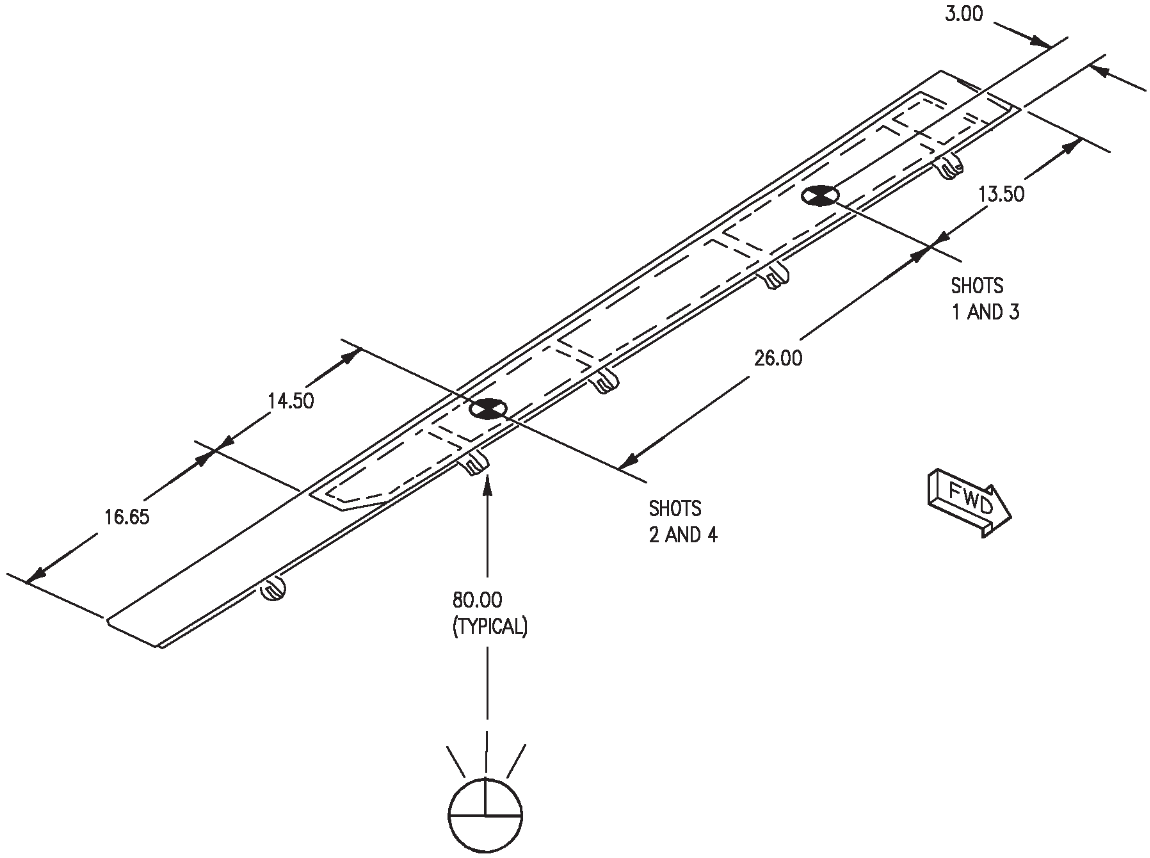


Figure 1. Aileron Shroud, Water in Honeycomb (Sheet 1)



TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1 AND 2	7 X 14 2	AA AND M	0.010 Pb	0.25 AL	5	50	1-1/2	1.00 - 3.5
3 AND 4	7 X 14 2	AA AND M	0.010 Pb	0.25 AL	5	75	1-1/2	1.00 - 3.5

LEGEND

1 H AND D DENSITY UNITS.

2 USE CUT AND BAGGED 14 X 17 INCH FILM.

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Figure 1. Aileron Shroud, Water in Honeycomb (Sheet 2)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

AILERON SHROUD

METAL TO METAL BOND LINE

PART NO. 74A170103

This WP supersedes WP012 00, dated 1 December 1992.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Integrated Flight Controls	A1-F18AC-570-300
Aileron and Aileron Shroud	WP010 00
Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **AILERON SHROUD.**

2. The aileron shroud is a bonded honeycomb assembly. Honeycomb core is 0.125 hexagonal cell, 5056 aluminum alloy. Skins are 7075 alclad and structure is 7075 aluminum alloy. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for metal to metal unbonds. Example of metal to metal unbonds that may develop in a bonded assembly is contained in WP003 00.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic, Fokker bond test.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
Model 80	Fokker Bond Tester
3814	Fokker Probe
Yellow Bond Tester Adapter	Probe Adapter Assembly

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-I-25135 TY1	Penetrant Emulsifier
ULTRAGEL II	Ultrasonic Couplant
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
M83953-1 or -2	Pencil, Aircraft Marking
A-A-883TYPE1-1-000IN	Tape, Pressure Sensitive

6. **Preparation of Aircraft.** Make sure aircraft is grounded (A1-F18AC-PCM-000) electrical, static, grounding.

7. **Access.** Have aileron shroud removed (A1-F18AC-570-300, WP010 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation for Part.** Clean area to be inspected with solvent moistened cloth to make sure inspection area is free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** See figure 1.

a. Connect bond tester to 110V ac outlet.

b. Connect Fokker probe, probe adapter assembly, and cable to bond tester.

c. Turn bond tester on by depressing ON button for 1 second.

d. Adjust front face settings:

DSP	Activated (Press to activate)
MODE.........................	M
S (Sweep Rate)..........	1
R (Sweep Range).......	5
F (Frequency Band)..	5

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

e. Apply couplant to section of area B.

NOTE

Areas B and C are both skin to core areas, however only B can be used for standardization. Step f. produces a representation of metal to metal unbond.

f. Position probe on area B.

g. Use FREQ. FINE and GAIN to get unbond A-scale response of 0 ±1 KHz and B-scale response of approximately 100, see figure 1, display 1. X-ray techniques may be used to locate skin to frame bond line.

10. **Inspection Procedure.**

a. Outline area A, metal to metal bonded area to be inspected, using an aircraft marking pencil.

b. Apply couplant to upper and lower surfaces of area A.

c. Position probe on area A and scan all area using a scanning index of 3/16 inch, half probe diameter.

d. Inspect bond line by monitoring A-scale numeric display. Maintain good coupling because an air response will appear similar to an unbond response. For this procedure a typical good bond response has an A-scale display between -15 and -30 KHz, see figure 1, display 2. Areas that produce an A-scale response of –5 KHz through 5 KHz indicate an unbond.

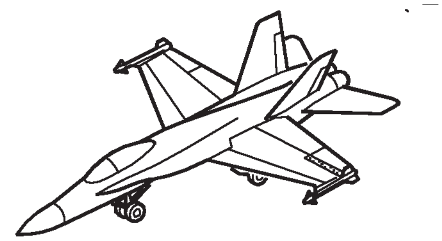
e. Mark all unbond response areas with aircraft marking pencil and record.

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

11. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection material and marks from inspection area(s) with cloth moistened with dry cleaning solvent or methyl isobutyl ketone.

12. **SYSTEM SECURING.** Have good shroud installed (A1-F18AC-570-300, WP010 00).

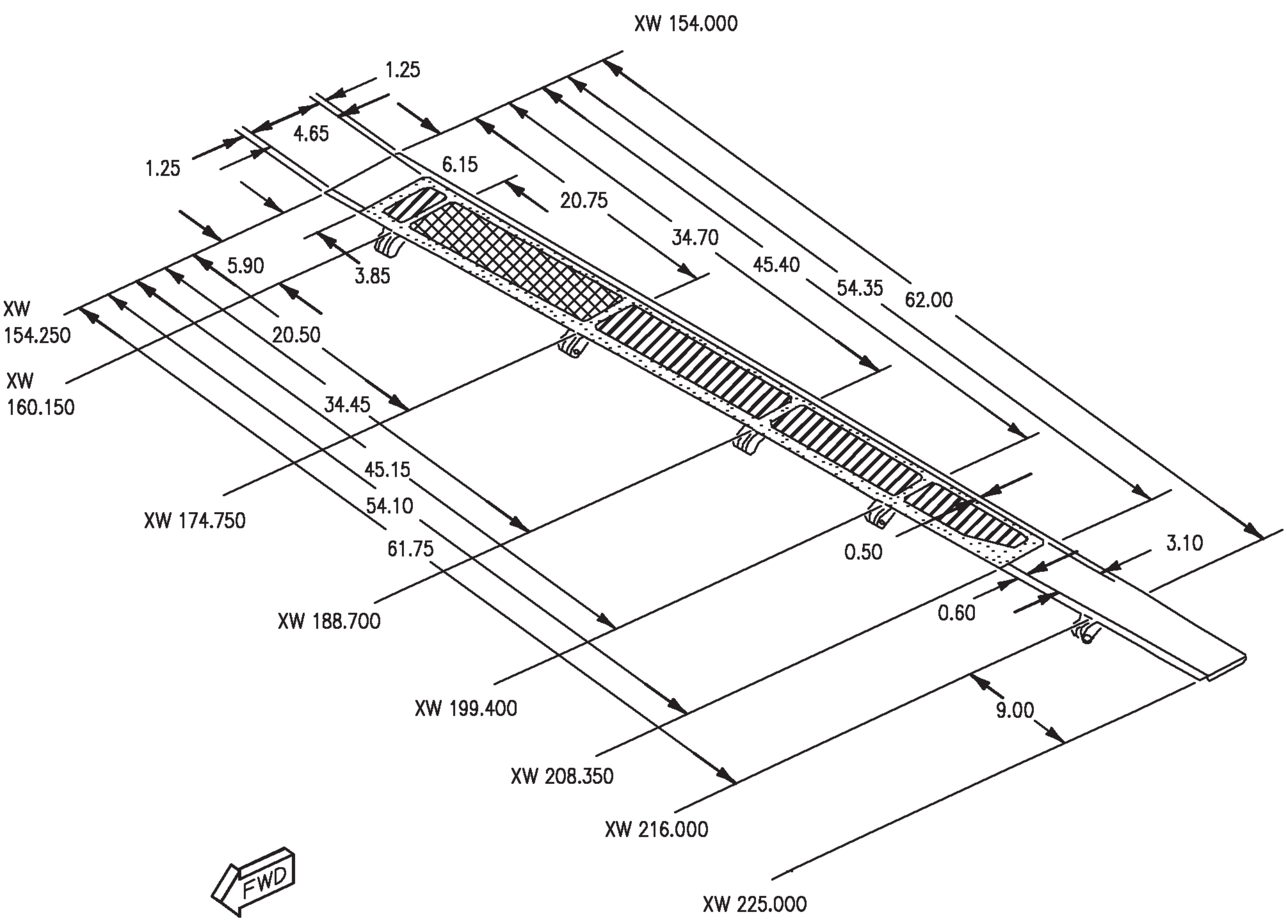


LEGEND

AREA A: SKIN TO FRAME (METAL TO METAL BONDLINE).

AREA B: STANDARDIZATION AREA (SKIN TO CORE BOND).

AREA C: NOT ACCEPTABLE FOR STANDARDIZATION (SKIN TO CORE BOND).



UPPER SURFACE

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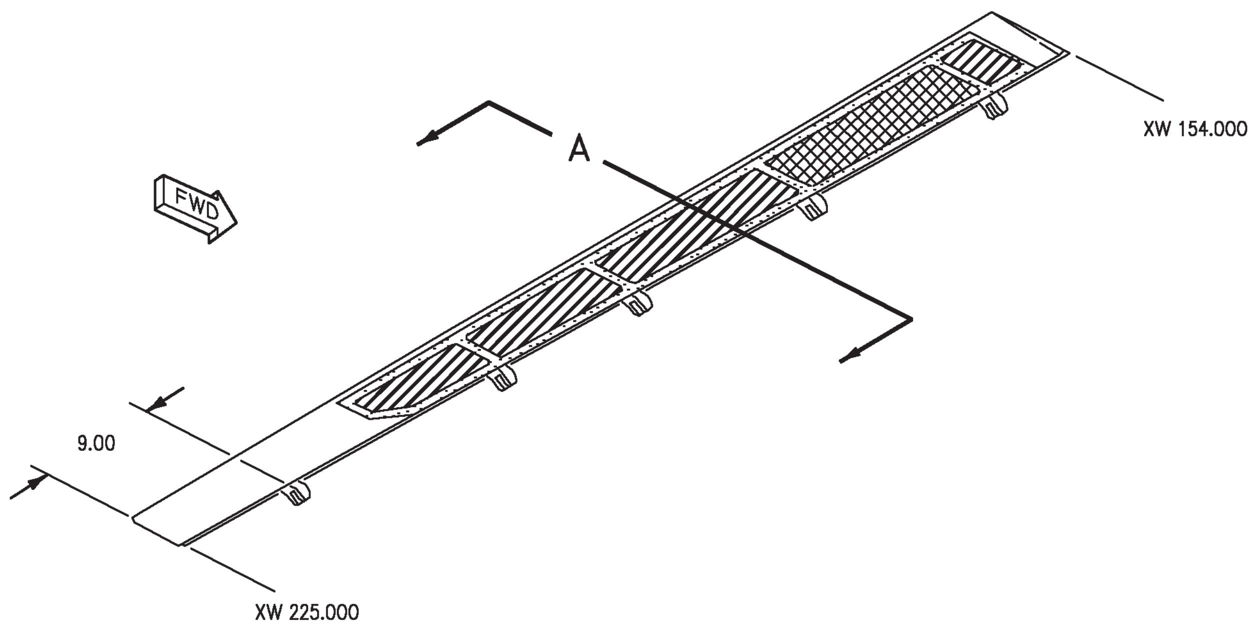
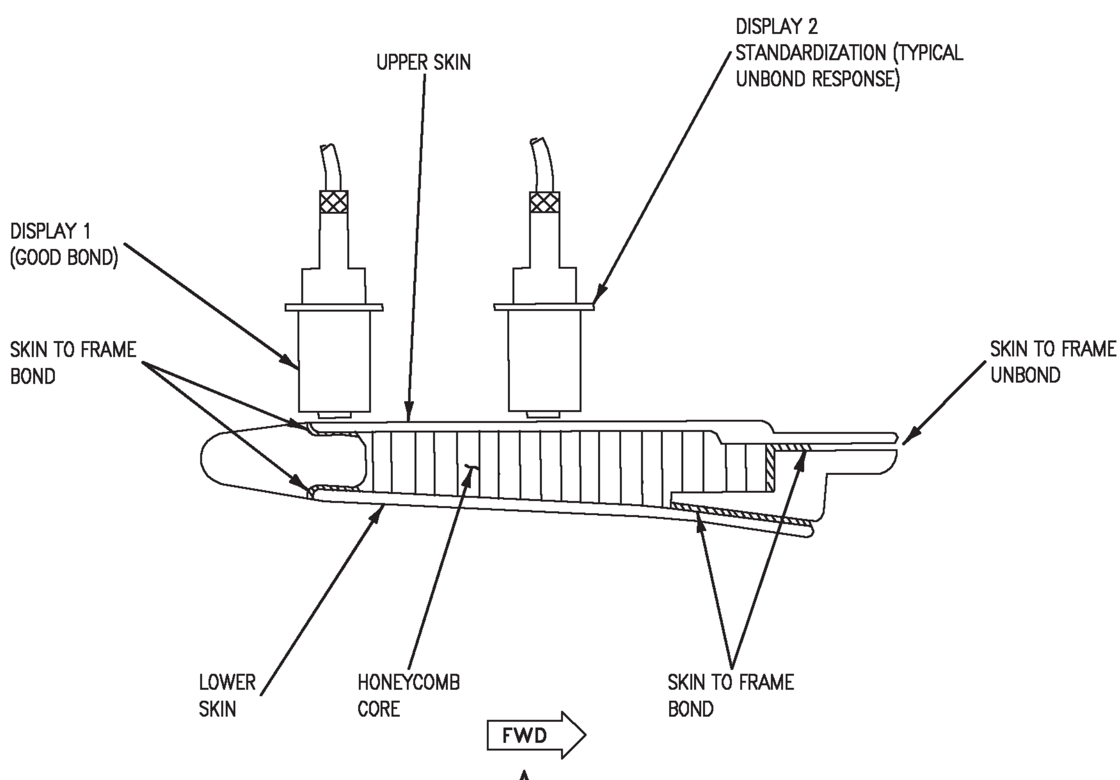
Figure 1. Aileron Shroud, Metal to Metal Bond Line (Sheet 1)



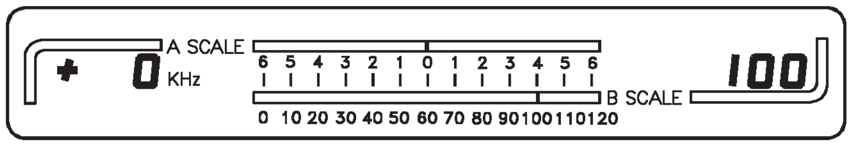
LOWER SURFACE



A

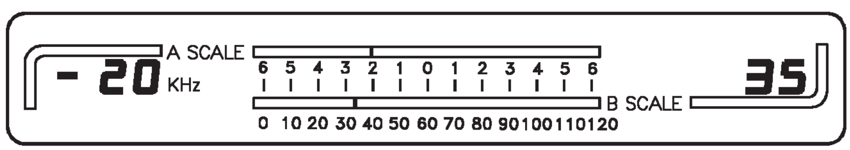
18AC-SRM-30-(95-2)30-SCAN

Figure 1. Aileron Shroud, Metal to Metal Bond Line (Sheet 2)



DISPLAY 1

STANDARDIZATION
RESPONSE



DISPLAY 2

TYPICAL RESPONSE FROM
GOOD BOND AREA

18AC-SRM-30-(95-3)30-CATI

Figure 1. Aileron Shroud, Metal to Metal Bond Line (Sheet 3)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

TRAILING EDGE FLAP

WATER IN HONEYCOMB

PART NO. 74A180002

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiographic Method	WP005 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **TRAILING EDGE FLAP.**

2. Trailing edge flap is bonded honeycomb assembly. Honeycomb core is 0.188 and 0.125 hexagonal cell, 5056 aluminum alloy. Skin and structure enclosing honeycomb core is graphite epoxy composite laminate. Leading edge structure, made from 7075 aluminum and graphite epoxy composite laminate, is fastened to graphite epoxy spar of bonded assembly. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians. NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX AA FILM CODE AA2 or INDUSTREX AAFILMCODE 14X17	Radiographic Film, X-ray Film 14 x 17 and 5 x 7
INDUSTREX M FILM CODE M-2	Radiographic Film, X-ray Film 14 x 7
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per data contained in technique chart, see figure 1.

10. **Inspection Procedure.**

NOTE

X-ray film for shots 1 through 4, 9, and 10 are double loaded. AA film is located next to part and both films exposed simultaneously.

a. Locate film 1 for shot 1. Film should be taped to upper surface of trailing edge flap with identification markers taped to source side of film pack and penetrameters taped to source side of trailing edge flap.

b. Locate source to aiming point for shot 1. Source should be normal to aiming point.

c. Expose film 1 using technique chart settings for shot 1. Remove exposed film.

d. Repeat steps a through c for films 2 and 3 and shot 2.

e. Repeat steps a through c for film 4 and shot 3.

f. Repeat steps a through c for film 5 and shot 4.

g. Repeat steps a through c for films 6 and 7 and shot 5.

h. Repeat steps a through c for film 8 and shot 6.

i. Repeat steps a through c for film 9 and shot 7.

j. Repeat steps a through c for film 10 and shot 8.

k. Repeat steps a through c for films 11 and 12 and shot 9.

l. Repeat steps a through c for films 13 and 16 and shot 10.

m. Repeat steps a through c for film 14 and shot 11.

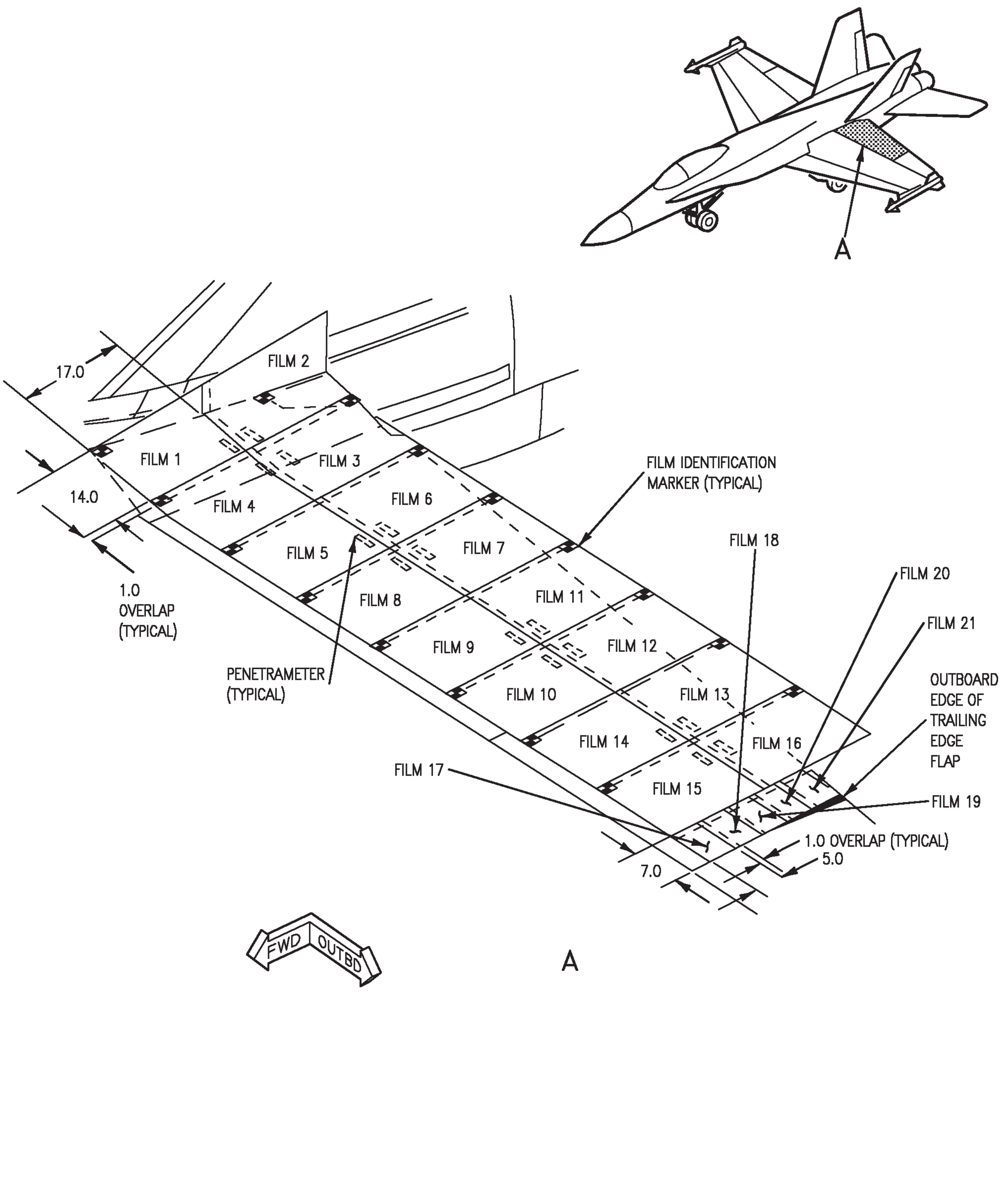
n. Repeat steps a through c for film 15 and shot 12.

j. Repeat steps a through c for films 17, 18, and 19 and shot 13.

k. Repeat steps a through c for films 20 and 21 and shot 14.

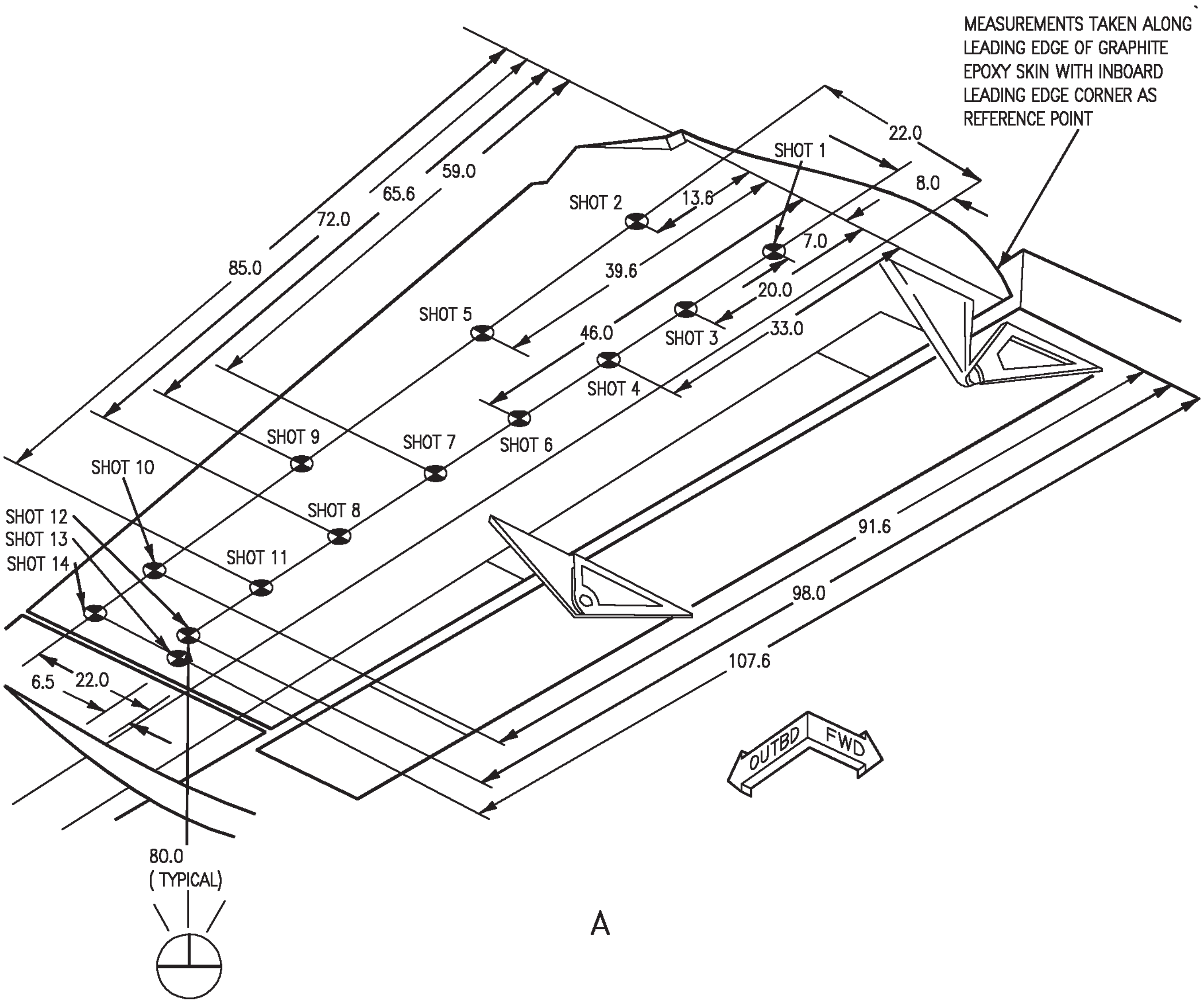
l. Process exposed film. Interpret radiographs for water trapped in honeycomb core (WP005 00).

m. Mark defect(s) using aircraft marking pencil.



18AC-SRM-30-(96-1)34-SCAN

Figure 1. Trailing Edge Flap, Water in Honeycomb (Sheet 1)



TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1 THRU 3	14 X 17	AA AND M	NO	0.25 AL	2.5	60	3	1.0-3.0
4 THRU 6	14 X 17	AA	NO	0.25 AL	2.5	50	2	1.0-3.0
7 THRU 8	14 X 17	AA AND M	NO	0.25 AL	2.5	55	2	1.0-3.0
9 THRU 12	14 X 17	AA	NO	0.25 AL	2.5	50	2	1.0-3.0
13 AND 14	5 X 7	AA	NO	0.25 AL	2.5	50	2	1.0-3.0

LEGEND

1 H AND D DENSITY UNITS

18AC-SRM-30-(96-2)34-SCAN

Figure 1. Trailing Edge Flap, Water in Honeycomb (Sheet 2)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

TRAILING EDGE FLAP

SKIN TO CORE UNBONDS AND DELAMINATIONS

PART NO. 74A180003

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiographic Method	WP005 00
Ultrasonic Through Transmission Contact Testing, Standardization, and Inspection Procedures For Composite Laminate Skins Bonded to Honeycomb Core	WP008 01
Pulse-Echo, Longitudinal Wave Contact, Without Delay Line, For Compo site Laminate Material	WP008 02
Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material Bonded to Honeycomb Core	WP008 04
Ultrasonic through Transmission Contact Testing, Standardization, and Inspection Procedures for Composite Laminate and Metallic Skins Bonded to Honeycomb Core	WP008 10
Pulse-Echo Longitudinal, Contact, Without Delay Line, for Composite Laminate Materials	WP008 11
Pulse-Echo Longitudinal, Contact, With Delay Line, for Composite Laminate Material Bonded to Honeycomb Core	WP008 13

Alphabetical Index

Record of Applicable Technical Directives

None

1. **TRAILING EDGE FLAP.**

2. See figure 1. Trailing edge flap is bonded honeycomb assembly. Honeycomb core is 0.125 and 0.188 hexagonal cell, 5056 aluminum alloy. Structure enclosing core is graphite epoxy closure ribs, forward spar, and skin. Skin to core and skin to substructure bonds are made with FM300 film adhesive. Core to closeout bonds are made with metal-filled foaming adhesive. Trailing edge closure is filled with Proseal 840 sealant. Surface finish is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect for skin to core unbonds and skin delaminations. Example of defects that may develop in bonded assembly is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable two Reqd
57A2276 or EQUIVALENT	0°, 0.500 Dia., 2.25 MHz, Contact Search Units two Reqd
57A2275 or EQUIVALENT	0°, 0.375 Dia., 2.25 MHz, Contact Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 inch
74D111295-1005	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies less than 1 inch
74D111295-1003	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies
74D111295-1001	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 2 inches or taller

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II or EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2,	Pencil, Aircraft Marking

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

9. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean both surfaces of inspection area(s) with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure part is free of contamination or foreign material.

b. On trailing edge flap, locate, mark, and identify inspection areas, core splice lines, and boundaries as shown in figures 1 and 2.

WARNING

Make sure safety precautions are met for electrical, static, grounding, when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores (A1-F18AC-PCM-000).

10. **Equipment Setting/Standardization/Setup for Skin to Core Areas.** See figures 3, 4, and 5. For All thicknesses of core, 1 inch or less, 1-2 inches, 2 or more inches, do standardization, (WP008 01). except as below:

a. Turn tester ON. Allow 15 minutes warmup.

b. Use two 57A2276 search units.

c. Use P-1 calibration point on applicable 74D111295 graphite/epoxy skinned honeycomb core sandwich assembly reference standard.

11. **Inspection Procedure for Skin to Core Areas.** After standardization, inspect skin to core areas shown in figure 1 and (WP008 01), except as below:

a. Use two 57A2276 search units.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to both surfaces of inspection area(s).

c. Make sure initial pulse width does not interfere with location of received response. If required, switch position of search units on microdot cables or use different search unit on receiver cable.

d. Use ultrasonic pulse-echo, (WP008 04), to determine if suspect areas are result of skin delaminations. Do pulse-echo inspection on both surfaces to help identify location of flaws causing through transmission unbond response. Use figure 6 to identify skin thicknesses in suspect areas.

12. **Standardization for Inspection of Sealant Filled Area.** Do standardization, (WP008 02), except as below:

a. Use one 57A2275 search unit.

b. Set tester front face settings:

NOTE

Equipment differences may require use of alternate COARSE SWEEP RANGE, FREQ, REP RATE, FINE SWEEP RANGE, VIDEO DISPLAY, DAMPING, and REJECT settings.

COARSE SWEEP RANGE	0.5 INCH
ATTENUATORS	ALL OUT

FILTER	OFF
COARSE SWEEP DELAY	0-3 INCHES
FREQ	2.25 MHz
MODE	PULSE-ECHO
FINE GAIN	MAX
REP RATE	AUTO
FINE SWEEP RANGE	MIN (OR AS REQUIRED
DAMPING	APPROX. MID SCALE
REJECT	APROX. 0
VIDEO DISPLAY	EITHER +, –, OR FULL WAVE

c. Coupling transducer to 0.250 thick step of 74D111295-1009 reference standard, adjust FINE SWEEP DELAY, FINE SWEEP LENGTH, and GAIN until CRT presentation similar to figure 7 is received.

13. **Inspection Procedure for Sealant Filled Area.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to one side of inspection area.

b. Position search unit on inspection area and adjust GAIN so reflected response is similar to figure 8, CRT 1.

c. Scan area to be inspected by finger damping back surface. Place couplant on end of finger and touch opposite surface of flap. As finger touches and is removed from part surface, reflected response on CRT will move up and down as it is damped, indicating good bond.

d. Unbond or delamination on search unit side will cause loss of reflected response on CRT, as shown in figure 8, CRT 2.

e. Unbond or delamination on side opposite search unit will result in no movement of reflected response on CRT as shown in figure 8, CRT 3.

f. Mark all areas with aircraft marking pencil where reflected response is lost or cannot be finger damped.

g. Use pulse-echo ultrasonic, (WP008 04) to determine if marked area is result of skin delaminations. Use figure 6 to identify skin thicknesses in area marked.

h. Do paragraph 19.

14. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable two Reqd
57A2276 or EQUIVALENT	0°, 0.500 Dia, 2.25 MHz, Contact Search Units two Reqd
57A2275 or EQUIVALENT	0°, 0.375 Dia, 2.25 MHz, Contact Search Unit
74D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates up to 0.450 inch
74D111295-1005	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies less than 1 inch
74D111295-1003	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
74D111295-1001	Honeycomb Reference Standard With Graphite Epoxy Skins for Sandwich Assemblies 2 inches or taller

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II or EQUIVALENT	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

WARNING

Make sure safety precautions are met for electrical, static, grounding, when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores (A1-F18AC-PCM-000).

15. **Equipment Setting/Standardization/Setup for Skin to Core Areas.** See figures 3, 4, and 5. For All thicknesses of core, 1 inch or less, 1-2 inches, 2 or more inches, do standardization, (WP008 10). except as below:

a. Turn tester ON. Allow 5 minutes warmup.

b. Use two 57A2276 search units.

c. Use P-1 calibration point on applicable 74D111295 graphite/epoxy skinned honeycomb core sandwich assembly reference standard.

16. **Inspection Procedure for Skin to Core Areas.** After standardization, inspect skin to core areas shown in figure 1 and (WP008 10), except as below:

a. Use two 57A2276 search units.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply couplant to both surfaces of inspection area(s).

c. Make sure initial pulse width does not interfere with location of received response. If required, switch position of search units on microdot cables or use different search unit on receiver cable.

d. Use ultrasonic pulse-echo, (WP008 13), to determine if suspect areas are result of skin delaminations. Do pulse-echo inspection on both surfaces to help identify location of flaws causing through transmission unbond response. Use figure 6 to identify skin thicknesses in suspect areas.

17. **Standardization for Inspection of Sealant Filled Area.** Do standardization, (WP008 11), except as below:

a. Use one 57A2275 search unit.

b. Set COARSE GAIN to 4 and FINE GAIN to 0.

c. Set COARSE HORIZ SWEEP LENGTH to 2 and FINE HORIZ SWEEP LENGTH to 8.

d. Coupling transducer to 0.250 thick step of 74D111295-1009 reference standard, adjust FINE HORIZ SWEEP DELAY, FINE HORIZ SWEEP LENGTH, and GAIN until CRT presentation similar to figure 7 is received.

18. **Inspection Procedure for Sealant Filled Area.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to one side of inspection area.

b. Position search unit on inspection area and adjust GAIN so reflected response is similar to figure 8, CRT 1.

c. Scan area to be inspected by finger damping back surface. Place couplant on end of finger and touch opposite surface of flap. As finger touches and is removed from part surface, reflected response on CRT will move up and down as it is damped, indicating good bond.

d. Unbond or delamination on search unit side will cause loss of reflected response on CRT, as shown in figure 8, CRT 2.

e. Unbond or delamination on side opposite search unit will result in no movement of reflected response on CRT as shown in figure 8, CRT 3.

f. Mark areas with aircraft marking pencil where reflected response is lost or cannot be finger damped.

g. Use pulse-echo ultrasonic, (WP008 13) to determine if marked area is result of skin delaminations. Use figure 6 to identify skin thicknesses in area marked.

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

19. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection area(s) with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection area(s) is free of contamination and foreign material.

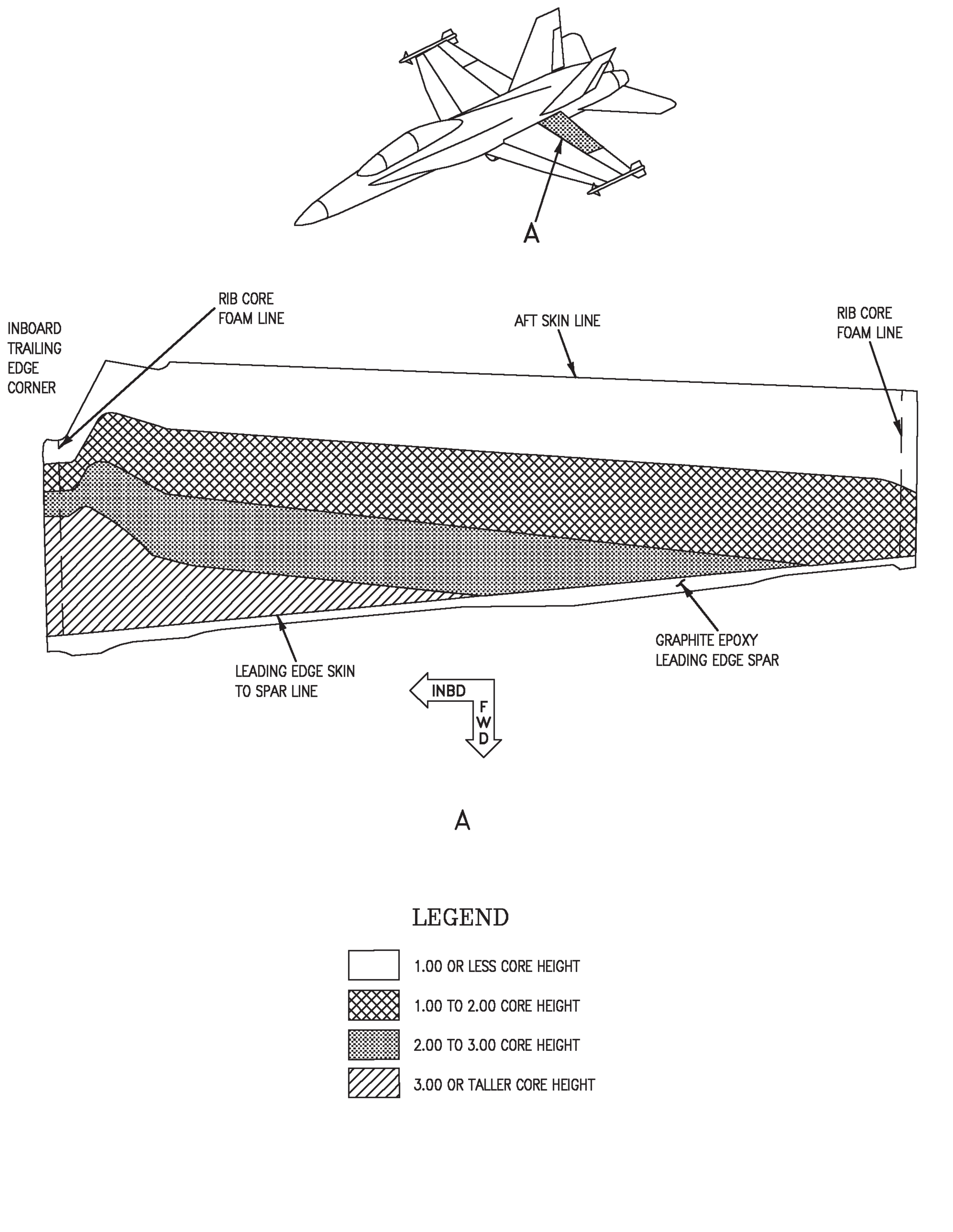


Figure 1. Trailing Edge Flap Inspection Areas and Internal Structure (Sheet 1)

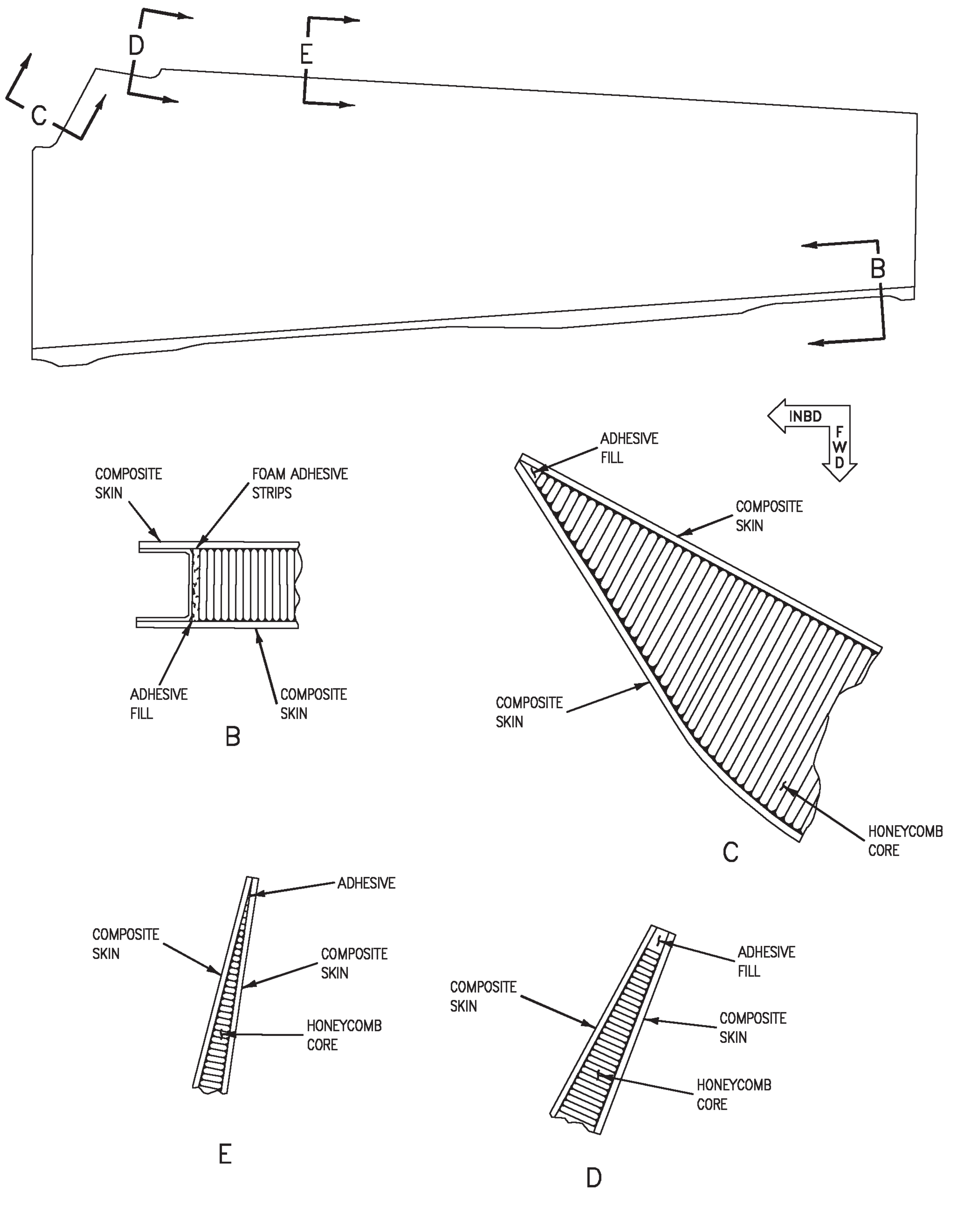
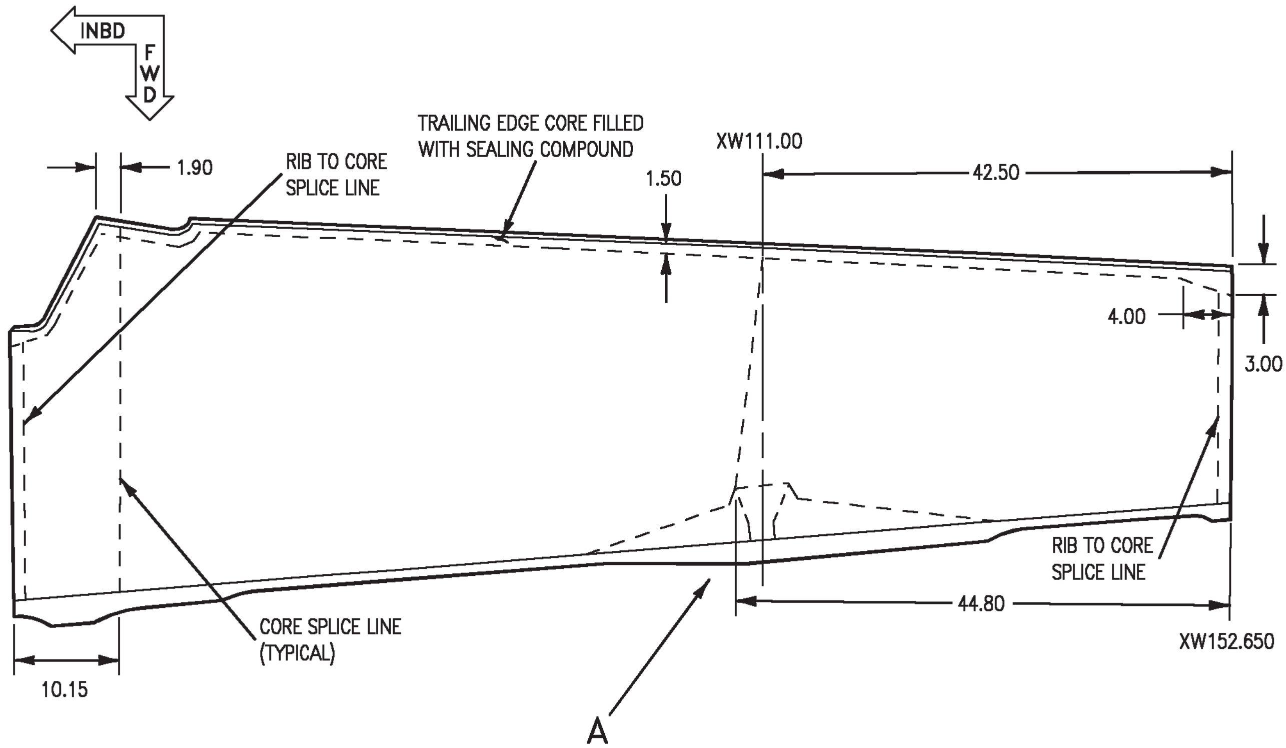
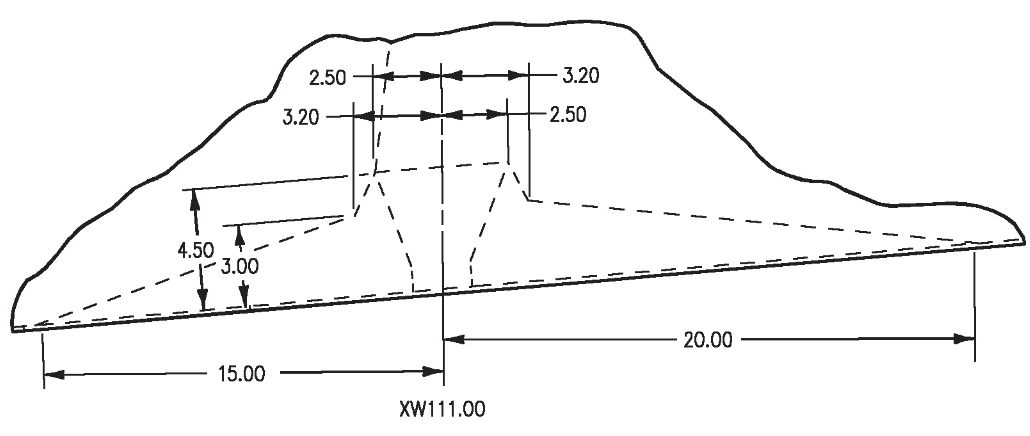


Figure 1. Trailing Edge Flap Inspection Areas and Internal Structure (Sheet 2)





A

18AC-SRM-30-(98-1)32-SCAN

Figure 2. Core Splice Lines

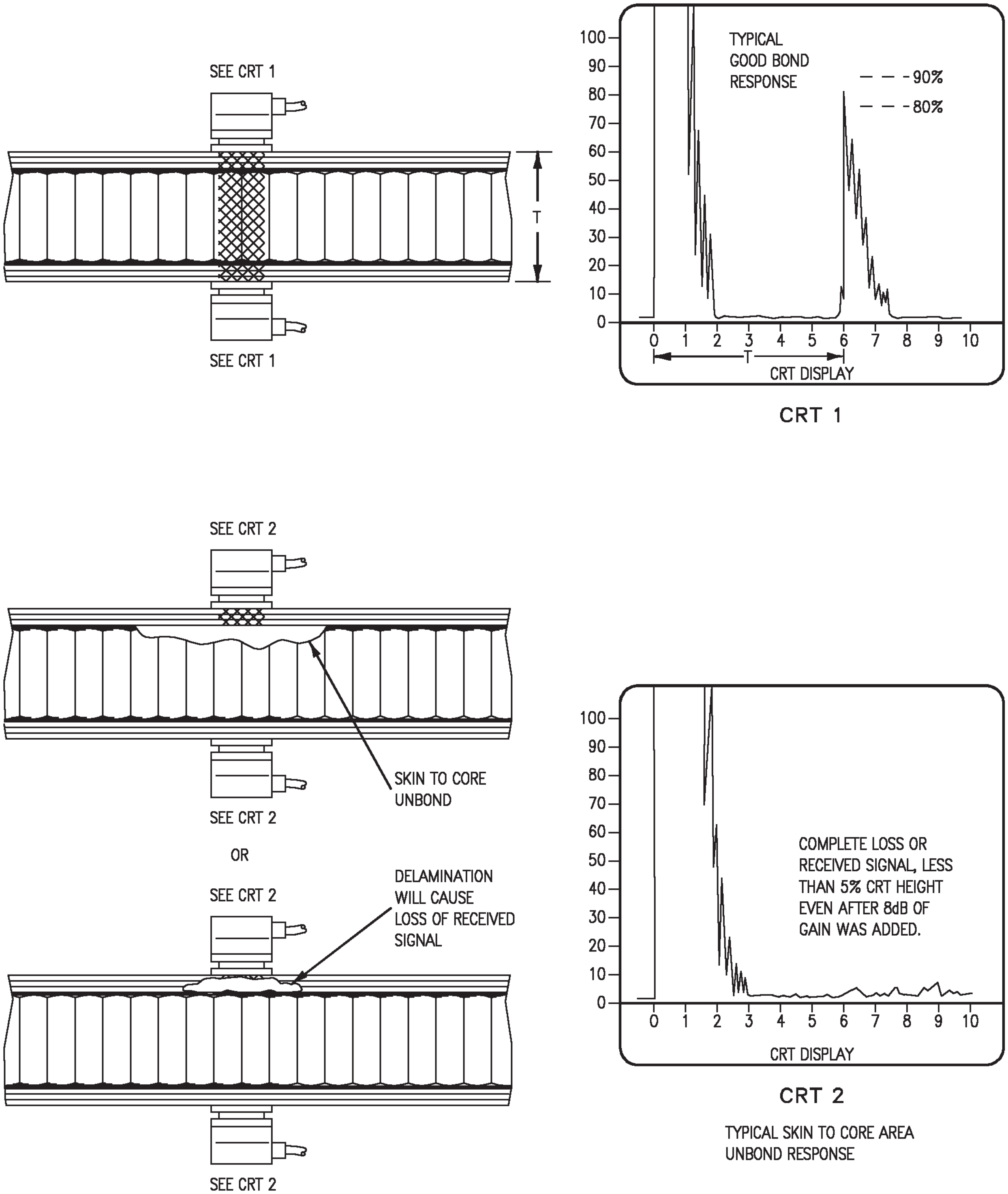


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Figure 3. Honeycomb Core Inspection Response in Area Where Core Height is 1 Inch or Less

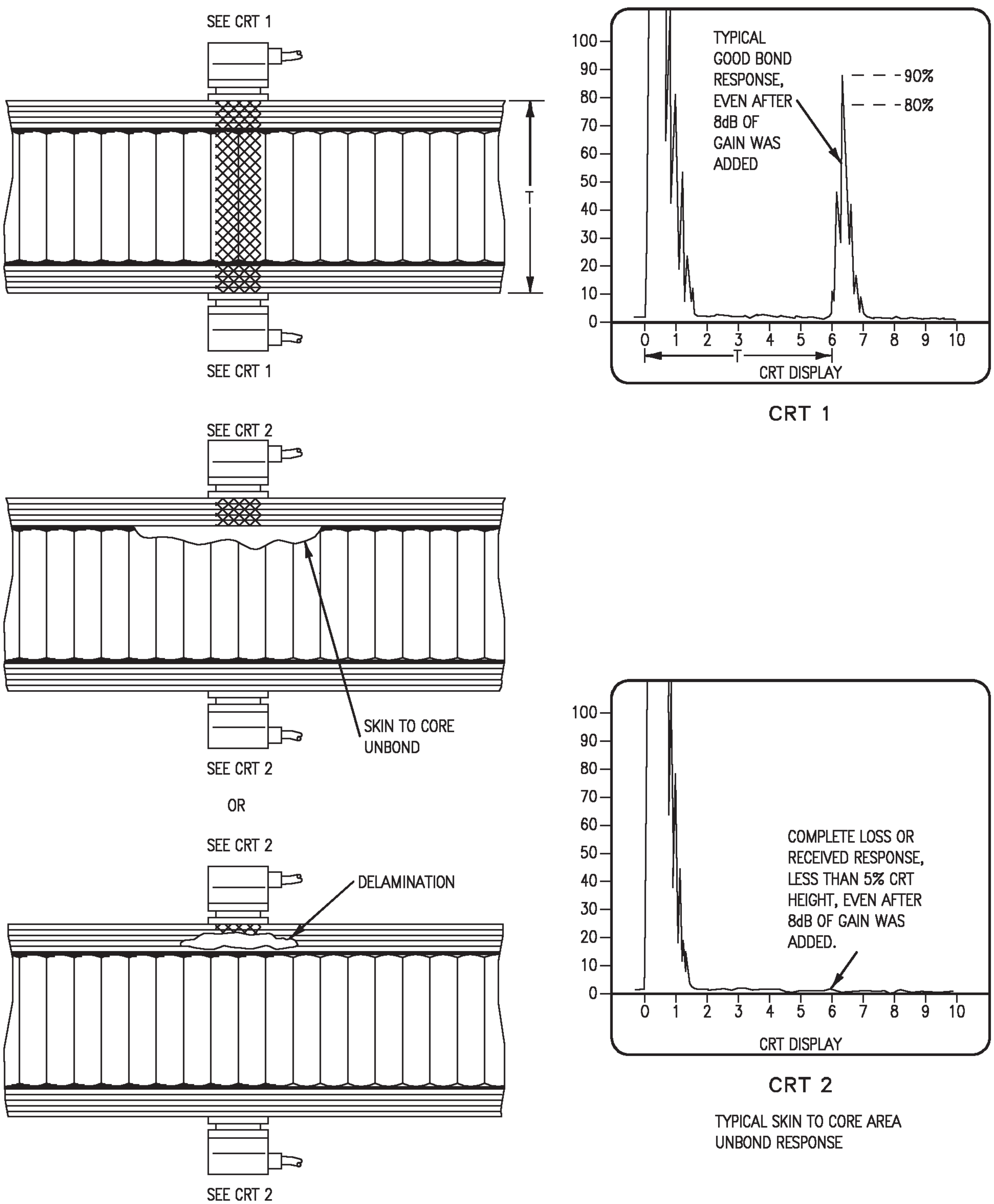

Figure 4. Inspection Procedures for 1 to 2 Inches Tall Honeycomb Core Area

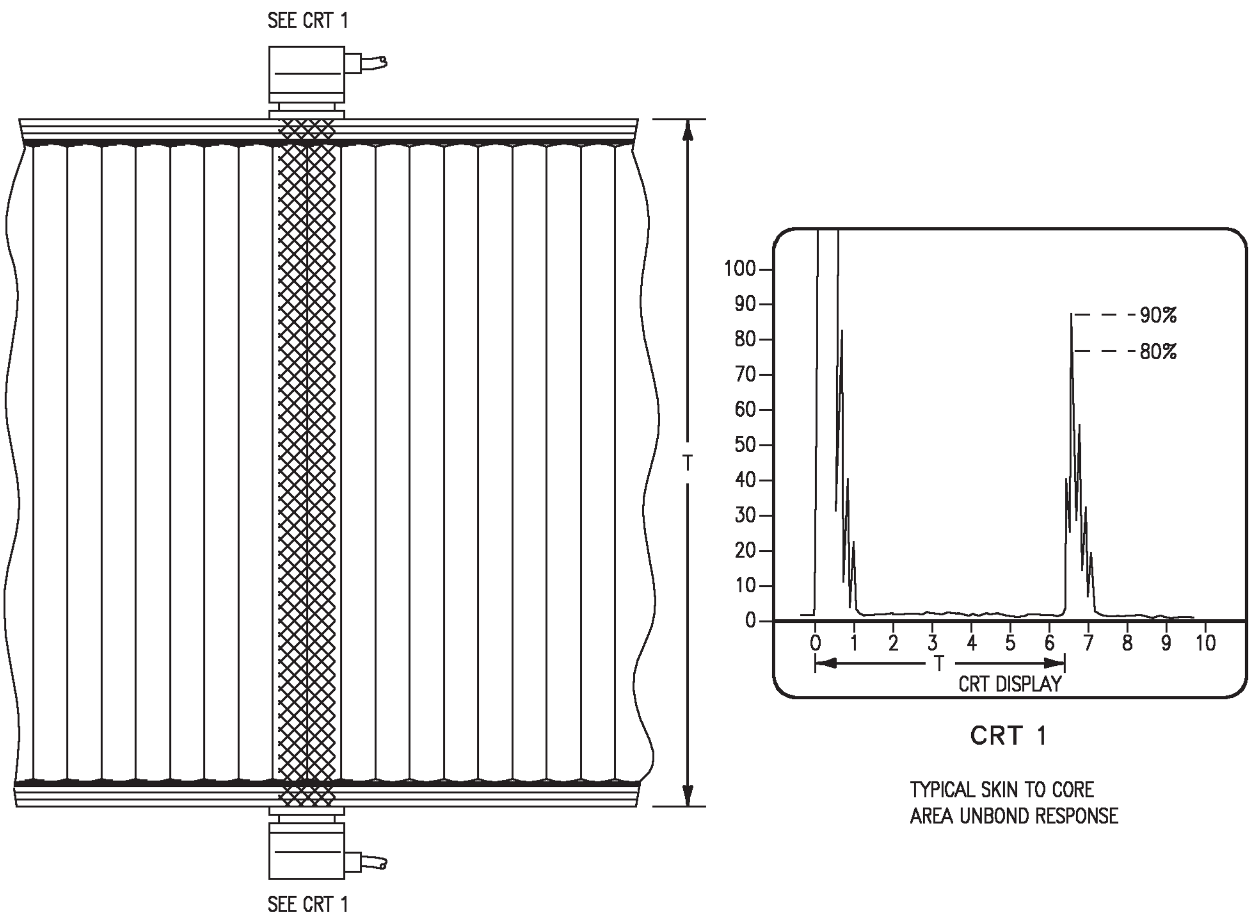

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Figure 5. Inspection Procedures for 2 Inches or Taller Honeycomb Core Areas (Sheet 1)

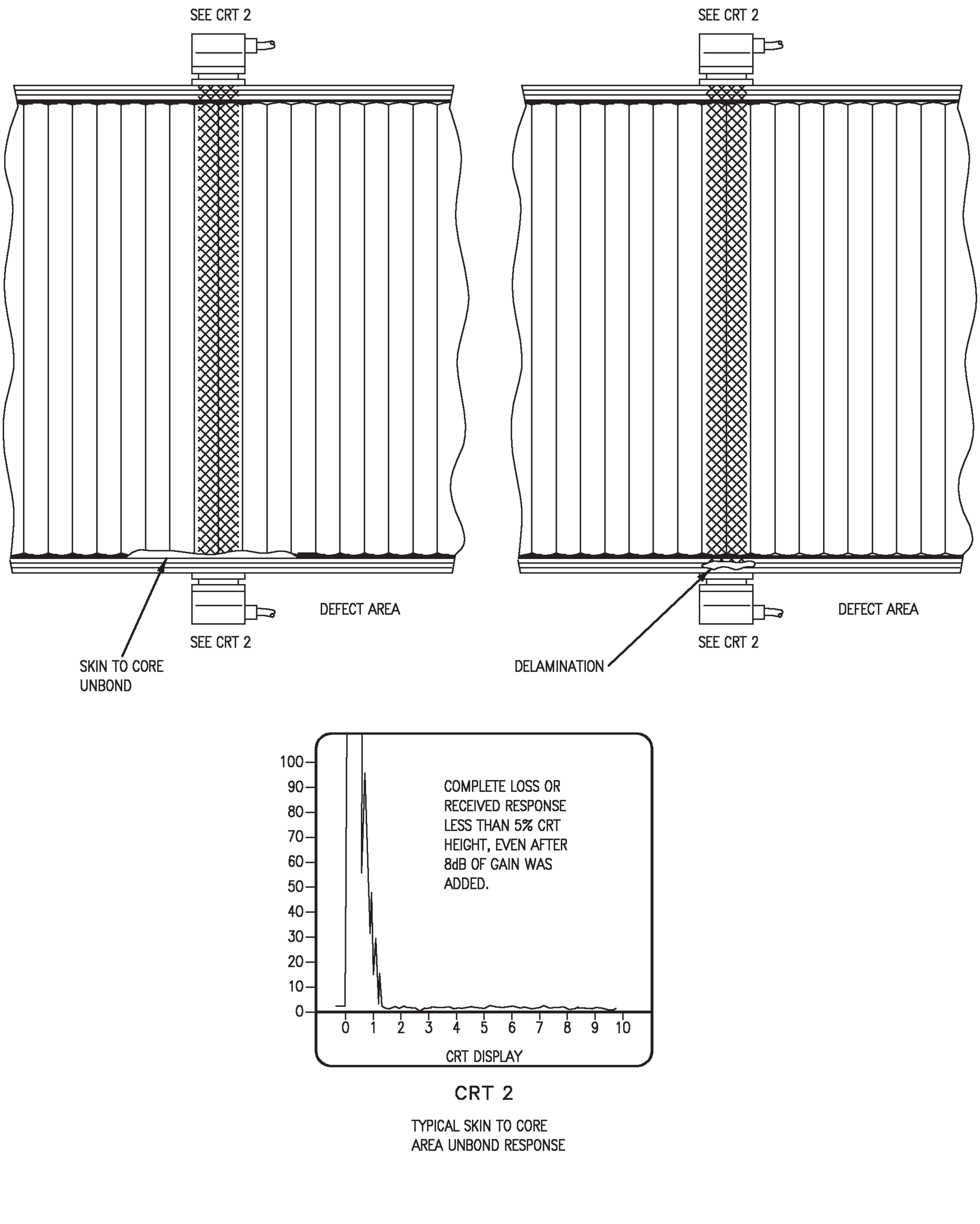
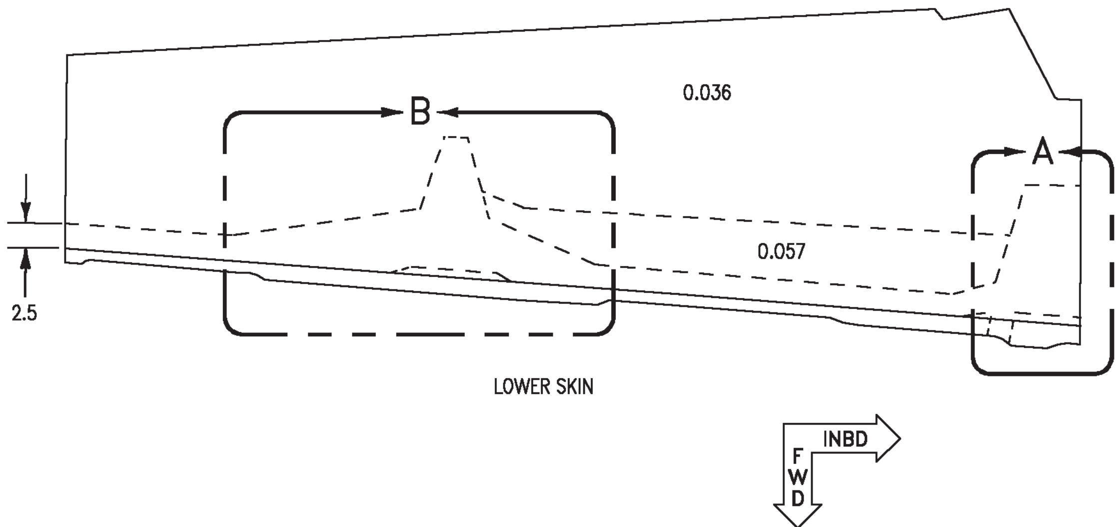
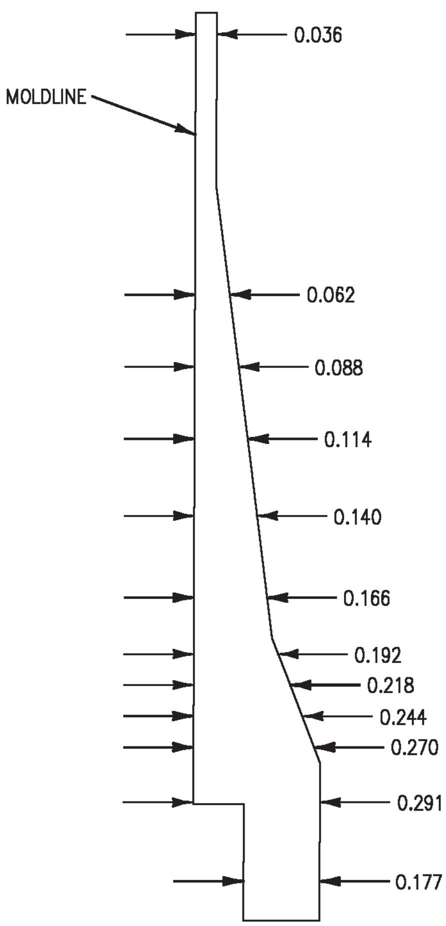
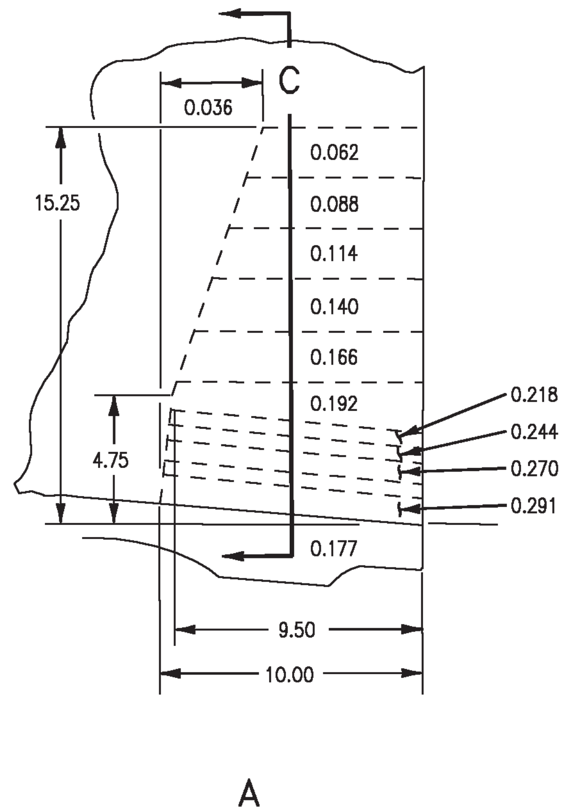


Figure 5. Inspection Procedures for 2 Inches or Taller Honeycomb Core Areas (Sheet 2)

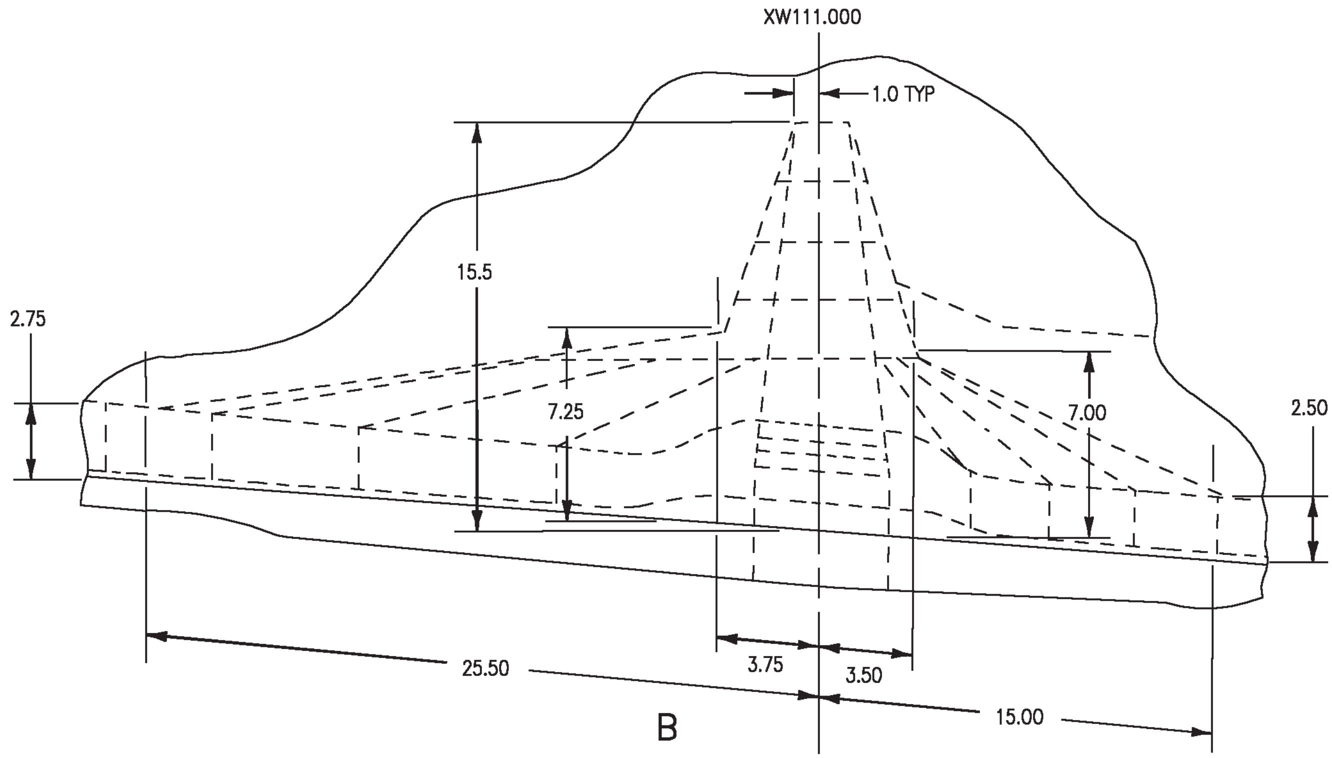




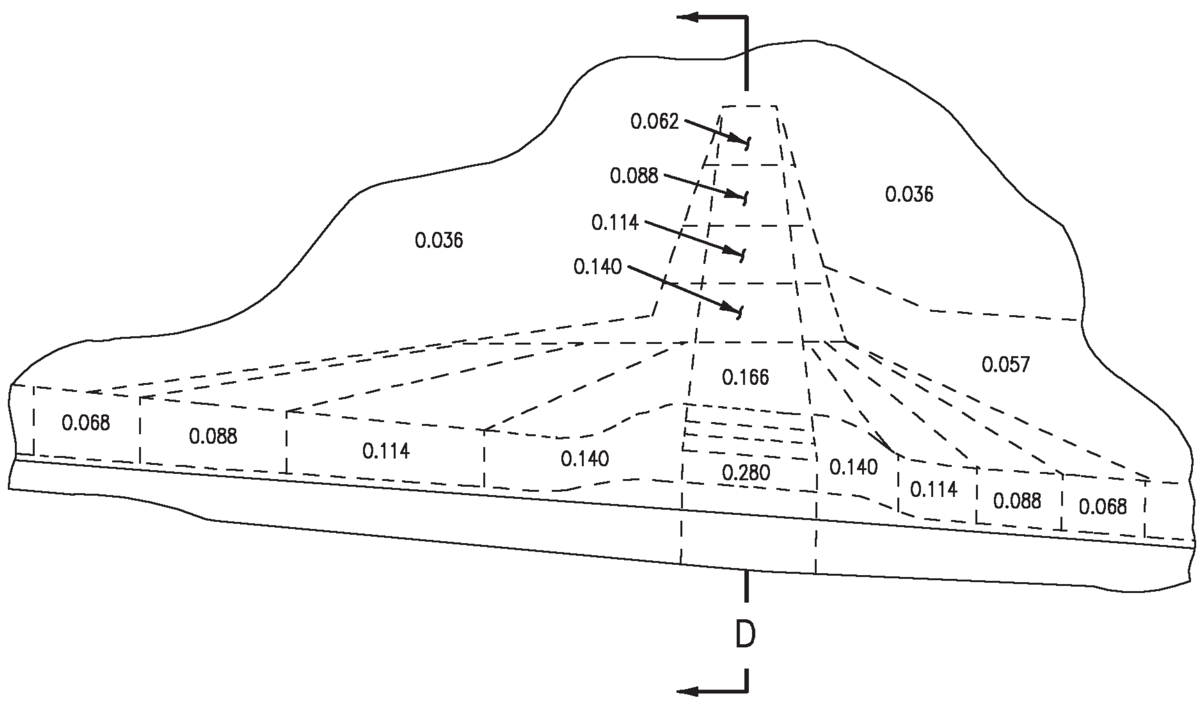


18AC-SRM-30-(103-1)35-SCAN

Figure 6. Skin Thicknesses (Sheet 1)



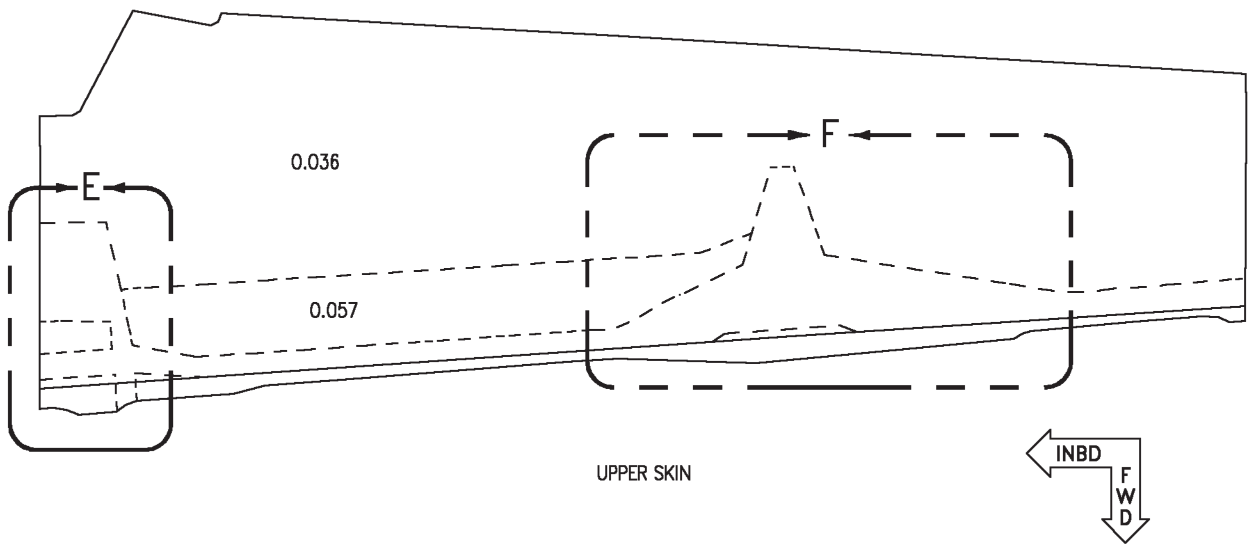
B
LOCATIONS

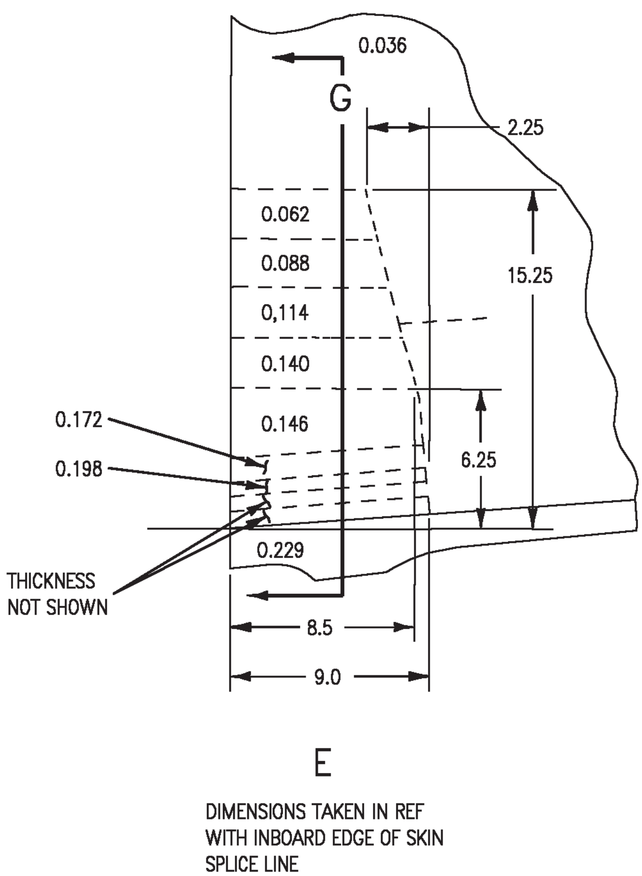


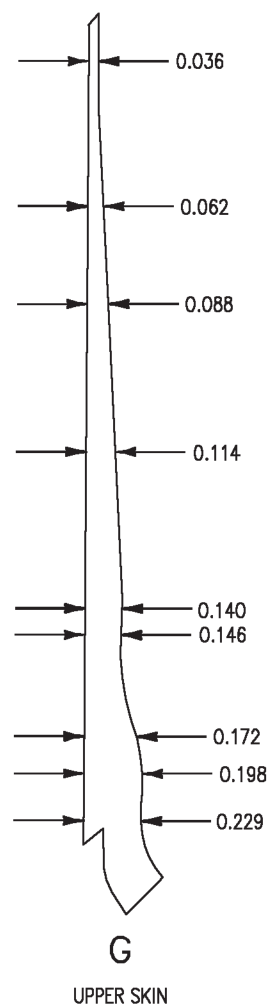
B
SKIN THICKNESS

18AC-SRM-30-(103-2)35-SCAN

Figure 6. Skin Thicknesses (Sheet 2)

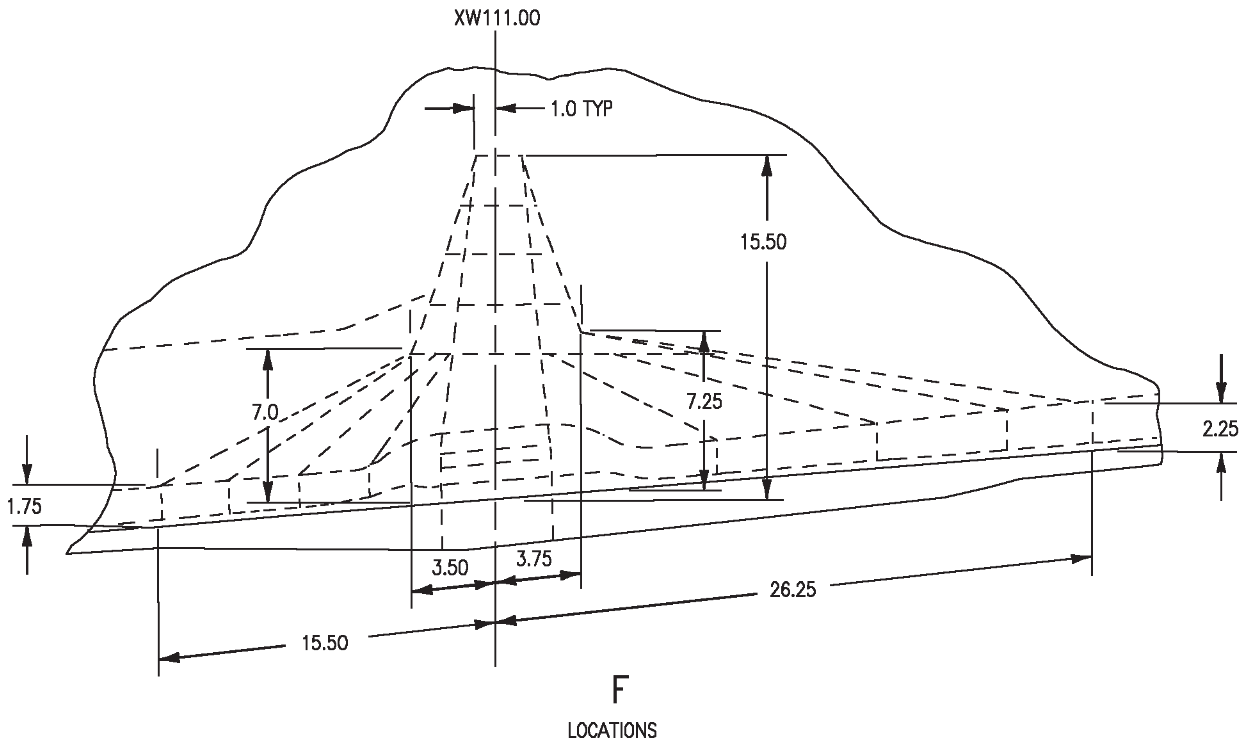






18AC-SRM-30-(103-3)35-SCAN

Figure 6. Skin Thicknesses (Sheet 3)



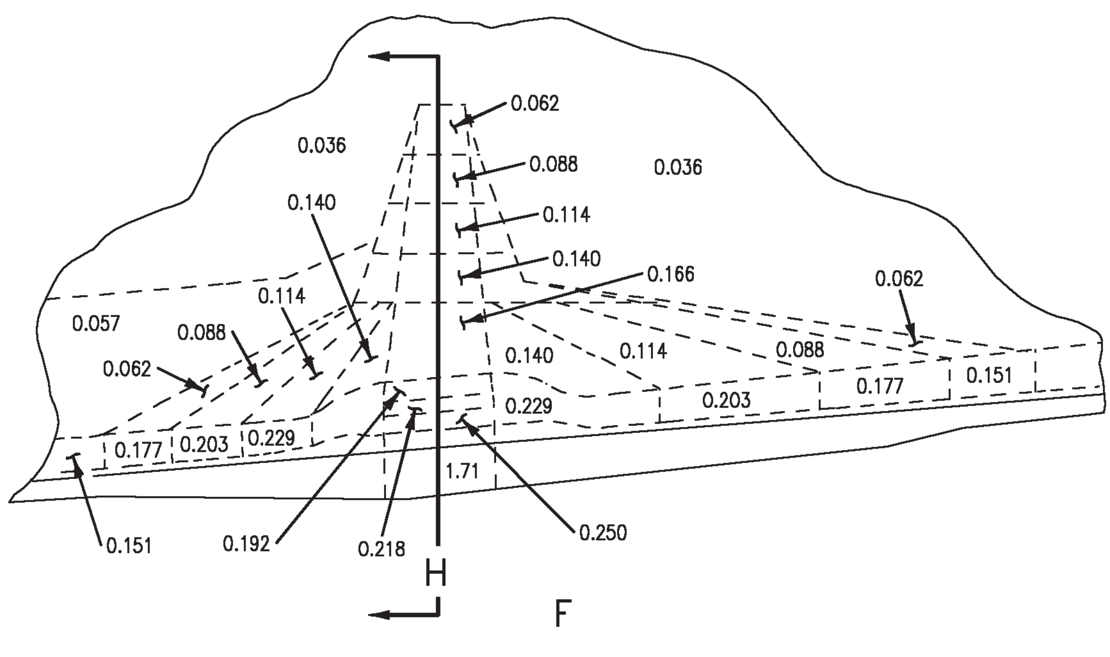


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Figure 6. Skin Thicknesses (Sheet 4)

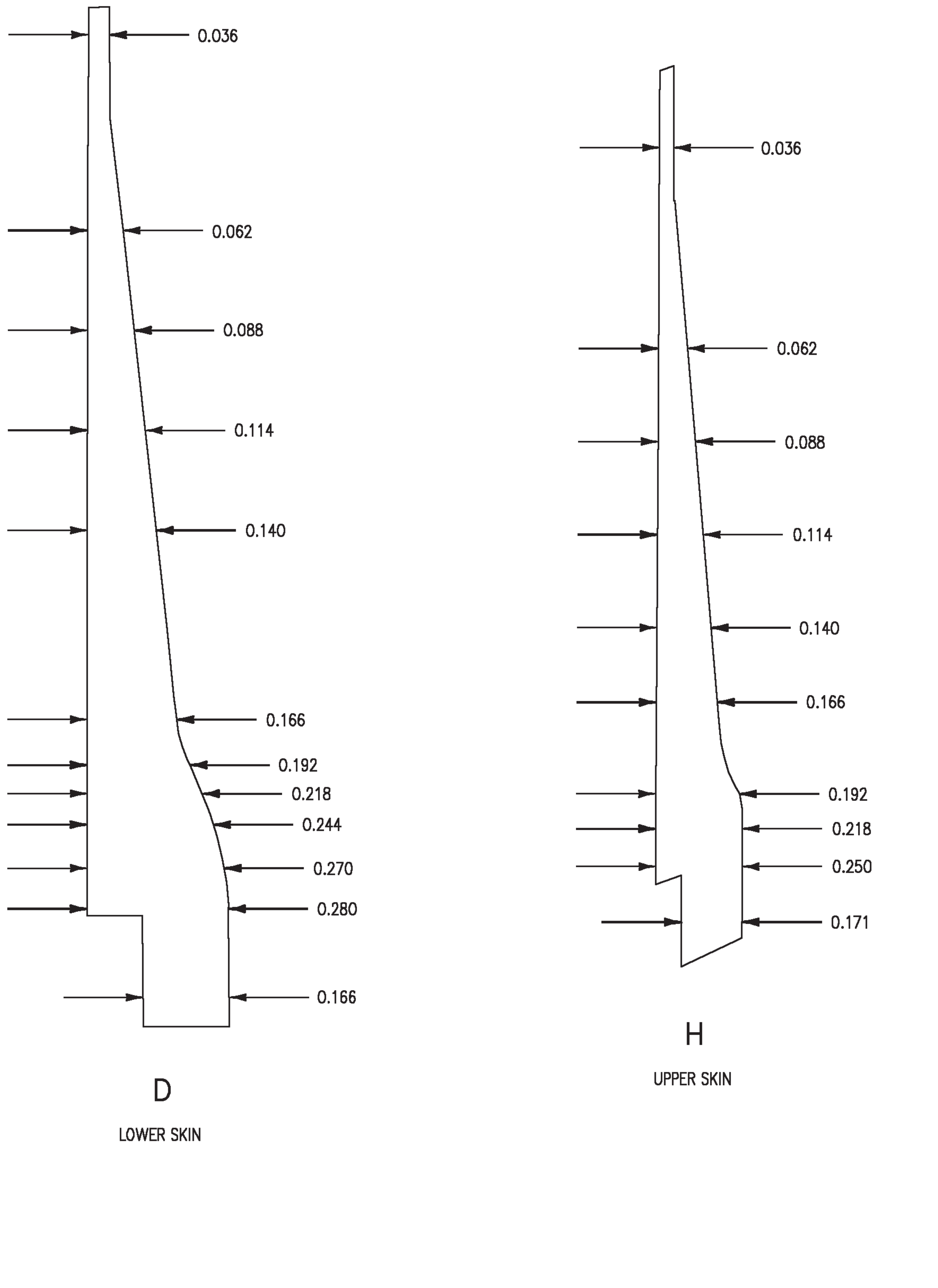
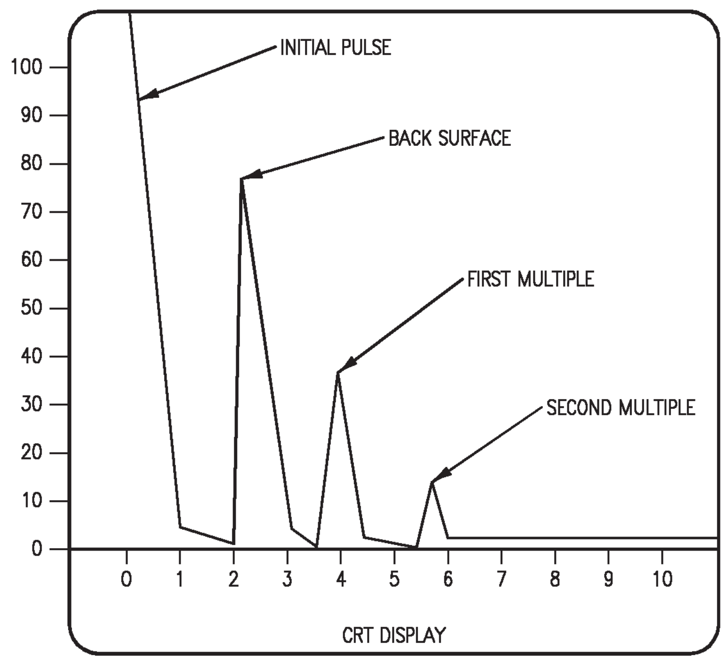


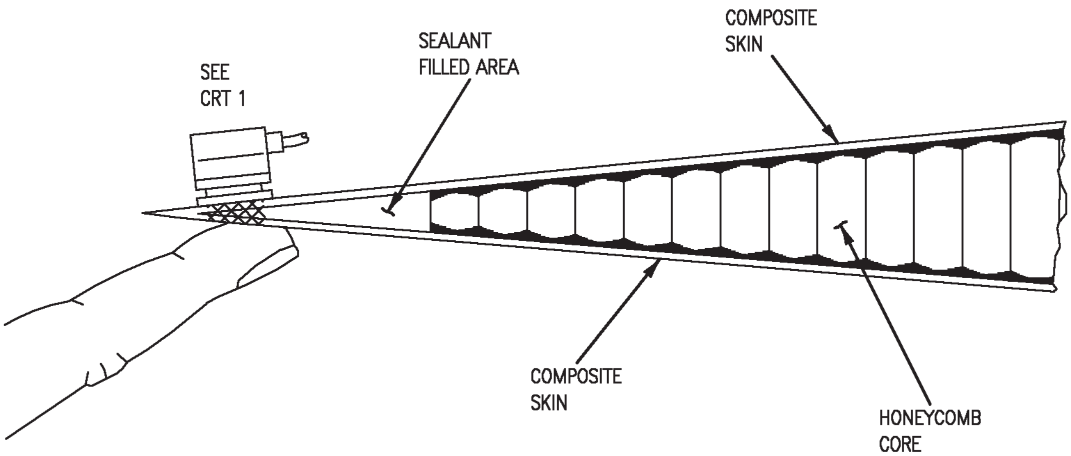
Figure 6. Skin Thicknesses (Sheet 5)

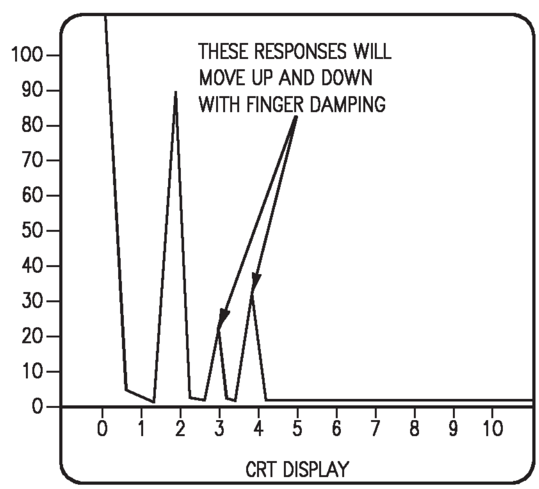


CRT 1

18AC-SRM-30-(445-1)35-CATI

Figure 7. CRT Responses for Filled Area Inspection

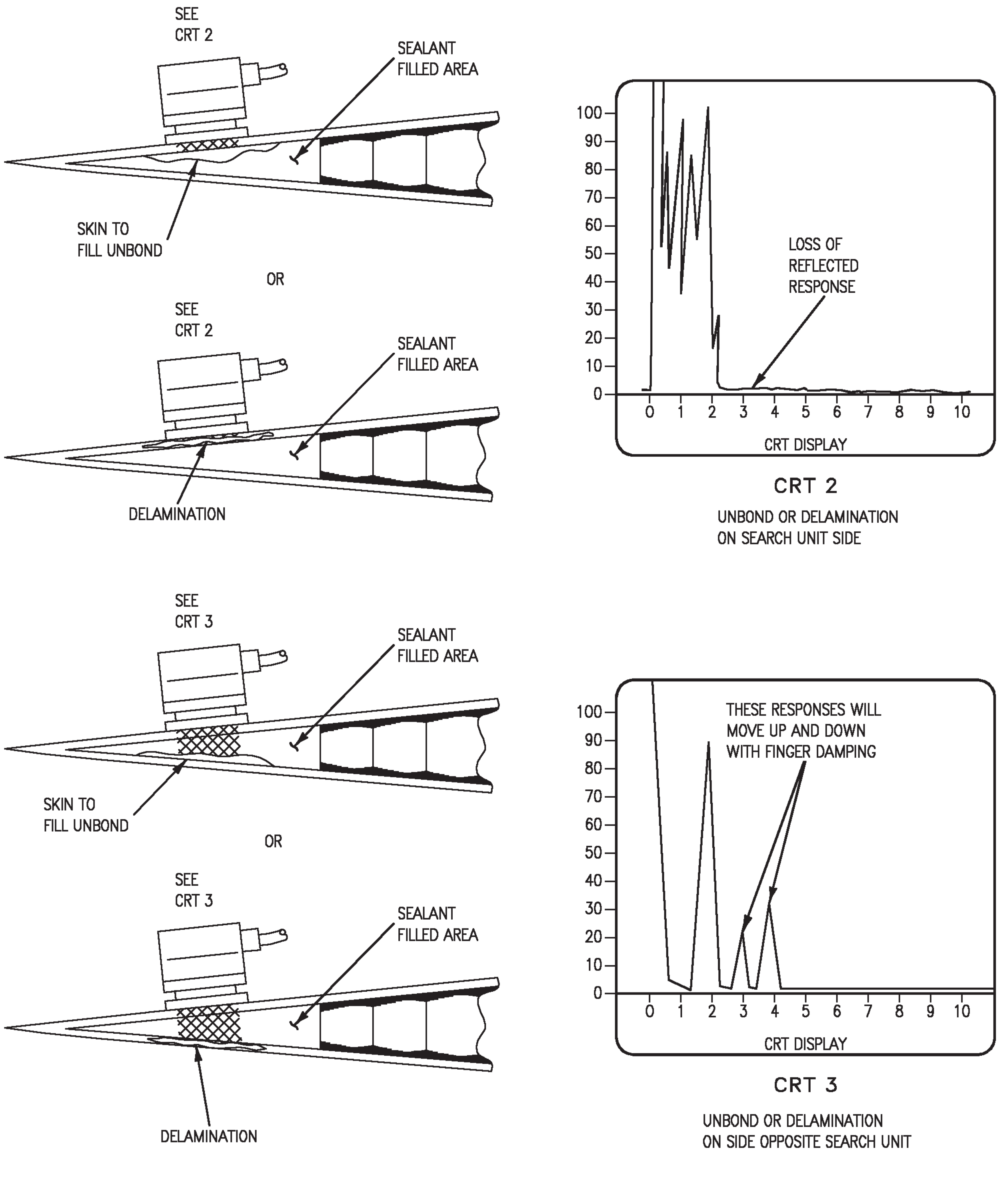




CRT 1

18AC-SRM-30-(446-1)35-SCAN

Figure 8. Ultrasonic Responses in Filled Area (Sheet 1)



18AC-SRM-30-(446-2)35-SCAN

Figure 8. Ultrasonic Responses in Filled Area (Sheet 2)

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

TRAILING EDGE FLAP OUTBOARD ROLLER SUPPORT FITTING

PART NO. 74A180687

This WP supersedes WP014 01, dated 15 March 1993.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Structure Repair, Wing	A1-F18AC-SRM-211
Trailing Edge Flap, Leading Edge Metal Skins	WP008 01
Structure Repair, Wing	A1-F18AE-SRM-600
Trailing Edge Flap, Leading Edge Metal Skins	WP015 00

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No.	Date Incorp.	Remarks
F/A-18 AFB 237 Rev A	-	Trailing Edge Flap Outboard Roller Support Fitting	15 March 93	-

1. TRAILING EDGE FLAP OUTBOARD ROLLER SUPPORT FITTING.

2. Trailing edge flap outboard roller support fitting (support fitting), see figure 1, is made from 7075 aluminum plate tempered to T73651. Finish system is sulfuric acid anodize, one coat epoxy primer, and two coats polyurethane enamel. Internal surfaces of holes are unfinished

3. **DEFECTS.** Inspect support fitting for cracks.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044..

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.**

a. Have skin, 74A180689, removed from trailing edge flap outboard roller support fitting area (A1-F18AC-SRM-211, WP008 01 , or A1-F18AE-SRM-600, WP15 00).

b. Have roller bearings removed from support fitting, see figure 1.

NOTE

Reference standard is considered equivalent for hole inspections if it is same base material and contains correct hole sizes. Holes shall have electrical discharge machined (EDM) notches 0.015 inches deep and 0.003 inches wide through thickness of reference standard. Any impedance plane eddy current equipment may be used for this procedure in conjunction with any probe, provided equipment and probe are standardized similar to paragraph 9. In addition, alternate ferrite shielded probes may be used with NDT-25N if they are standardized in manner identical to paragraph 9. Exact tester settings may vary. ED-520 eddy current tester may be used for thick procedure if it is setup per (WP007 00).

Support Equipment Required

NOTE

Alternate type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
NDT-25N (ED-520)	Programmable Eddyscope, Nortec, MXU-713/E

Support Equipment Required (Continued)

NOTE

Alternate type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
9505955	NDT-25N Accessory Kit
NRK-3AST	Navy Reference Standard Kit
1-HC-1/4	Ferrite Shielded, 1/4 Inch Dia, 4.5 Inches Long, 200 KHz, Absolute Coil Bolt Hole Probe
1-HC-3/8	Ferrite Shielded, 3/8 Inch Dia, 4.5 to 5 Inches Long, 200 KHz, Absolute Coil Bolt Hole Probe
57A2271	Microdot to BNC Connecting Cable, two Reqd

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
COMMERCIAL	Tube Type Marker
COMMERCIAL	Cellulose Tape
CCC-C-46, TYPE I CLASS 4	Cleaning Cloth

8. **Preparation of Part.**

a. Locate inspection area and visually inspect applicable surfaces using flashlight and mirror.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

NOTE

Do not remove bushing.

b. Clean inspection area with cloth moistened with cleaning compound.

c. Allow to air dry for 15 minutes after cleaning.

9. **Equipment Settings/Standardization/Setup.**

a. Attach ADN-B1 adapter, which is part of the NDT-25N accessory kit, to NDT-25N programmable eddyscope tester.

b. Attach two 57A2271 microdot to BNC connecting cables (cables) to adapter.

c. Attach probe being used for inspection to cable attached to front of adapter.

d. Attach other probe to cable connected to side of adapter. Probe connected to side of adapter is used as reference coil and must be kept away from electrically conductive material.

e. Set tester front face settings;

POWER	ON
STATUS LIGHTS	ON
GAIN	30
FREQ	200
FILTER	0
H SENS	0.5
V SENS	0.2
DISPLAY	H/V
I/O SWITCHES	OFF
ALARM	OFF
NON-STORE	OFF

f. Loosen set screw on probe guide.

g. Adjust probe collar until all coil is below collar. Be sure coil and set screw are aligned.

h. Tighten set screw finger tight, see figure 2, detail A.

i. Insert probe into NRK-3AL reference standard hole same size as hole to be inspected. Reference standard is part of the Navy reference kit, see figure 3. Position coil in hole approximately 90 degrees away from reference notch, see figure 2, detail B.

j. Press NULL and use POS buttons to locate dot in position shown on figure 2, CRT 1.

k. Press ERASE.

l. Do lift-off trace adjustment. If trace similar in direction to figure 2, CRT 2, is not displayed with probe in hole, adjust ANGLE and GAIN controls to get this response. Press NULL after any changes to GAIN.

m. After correct lift-off trace is received, rotate probe in reference standard at rate of one revolution per 5 to 10 seconds.

NOTE

If probe rocking occurs in unnotched area in hole of reference standard, trace similar to trace shown on figure 2, CRT 3, will be received. If probe has loose fit in hole, add one or two layers of rubber insert, cotton, or sponge ear plugs to probe slot and repeat steps i. through l.

n. Rotate coil past notch, trace similar to figure 2, CRT 4 should be received.

NOTE

Depending on depth of probe coil in reference standard hole and conductivity of reference standard, length of rotation of trace may differ from trace shown on figure 2, CRT 4.

10. **Inspection Procedure.**

a. Select either 3/8 or 1/4 inch hole probe, depending on hole to be inspected. To inspect 1/4 inch holes, probe will be threaded through 3/8 inch hole and collar will need to rest on surface around 3/8 inch hole, see figure 1. If collar can be slid off probe shaft and its short enough in length, it may be placed so it rests on surface around 1/4 inch hole.

NOTE

Make sure collar can rest flat on sides of holes.

b. Adjust collar so coil center is approximately 1/16 inch into hole.

c. Insert probe into hole to be inspected, see figure 1.

d. Press NULL button.

e. Rotate probe in hole about one rotation per 5 to 10 seconds. Traces similar to traces shown in figure 2, CRT's 1 through 3 should result.

f. Traces similar to figure 2, CRT 4, which are repeatable, shall be reported as crack indications.

g. If accurate interpretation of eddy current responses is not possible, because roller fitting hole has been worn to oblong or elliptical shape, discontinue inspection. Attempt to inspect all holes and seek engineering disposition for holes not able to be inspected.

h. If coil is shorting against hole wall, traces similar to figure 2, CRT 5 may result.

i. Often, traces will tend to be more vertical than traces shown in figure 2, CRT 5. To correct this problem, add one layer of teflon or cellulose tape over coil and restandardize.

j. After completing one revolution with probe collar at one setting, adjust probe collar so additional 1/16 inch exist between edge of probe collar and center of coil. Repeat steps c. through j. until entire hole depth has been inspected.

k. Repeat steps c. through j. for remaining holes and holes on opposite trailing edge flap.

11. **Acceptance limits.** Request engineering disposition for all holes that are elongated or have crack indications.

12. **Documentation.**

a. If no cracks are found, record this inspection in aircraft log book as completed.

b. If cracks are found, map location and provide dimensions on illustration similar to figure 4. Include information such as aircraft bureau number, total flight hours, airframe change number, date of inspection, and printed name of inspector.

c. Submit documentation sheet to local engineering for disposition. File one copy of documentation sheet and engineering disposition in aircraft log book, and provide local MCAIR representative with copy.

13. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

14. Clean inspection area with cloth moistened with cleaning compound.

a. Allow to air dry for 15 minutes after cleaning.

15. **SYSTEM SECURING.** Have skin, 74A180689, reinstalled (A1-F18AC-SRM-211, WP008 01 or A1-F18AE-SRM-600, WP015 00).

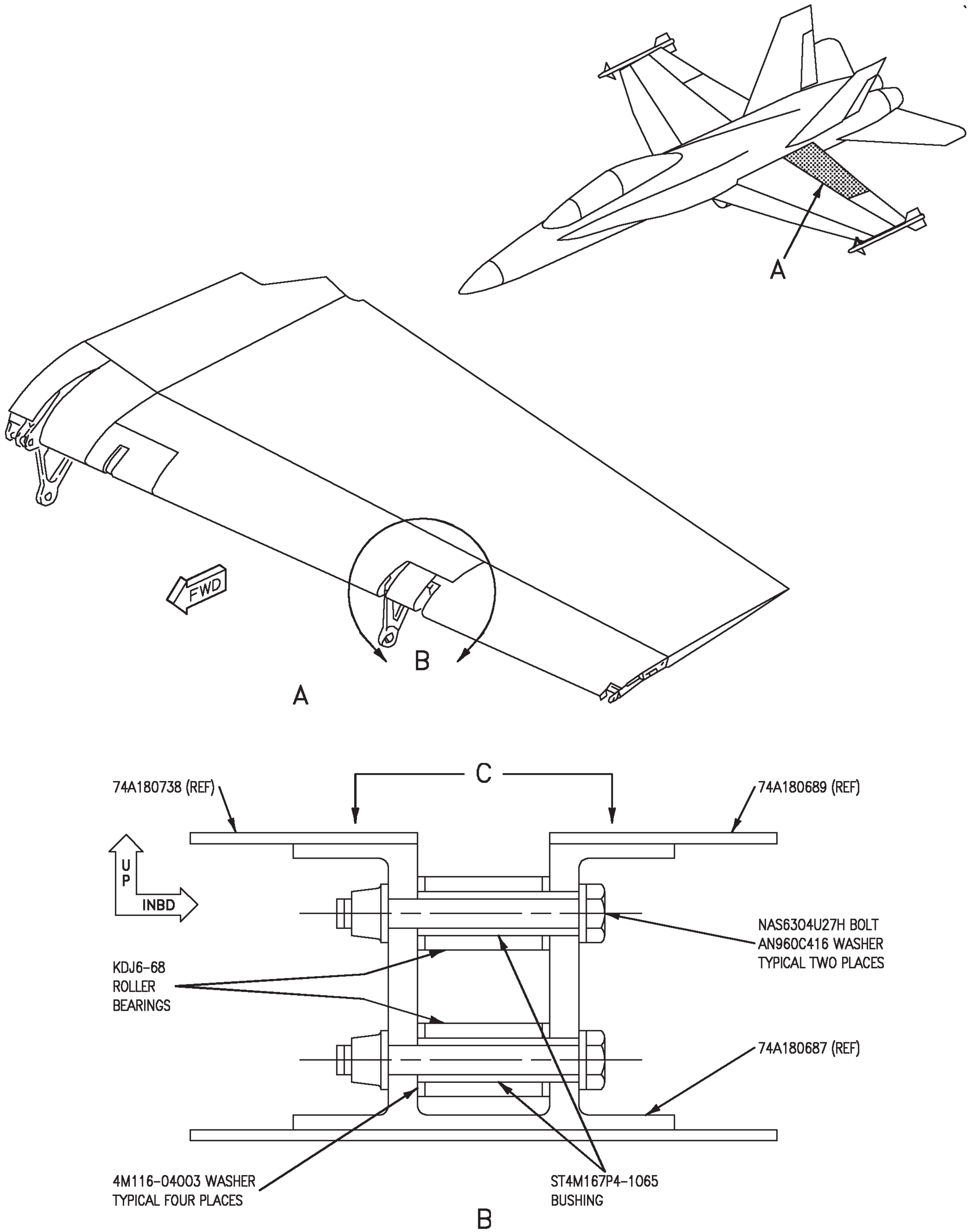
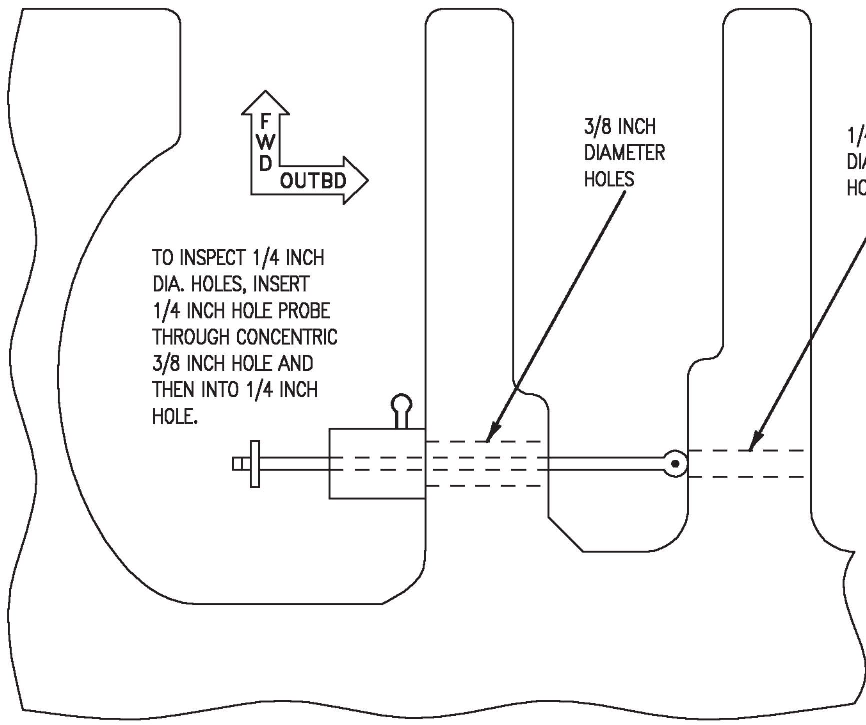
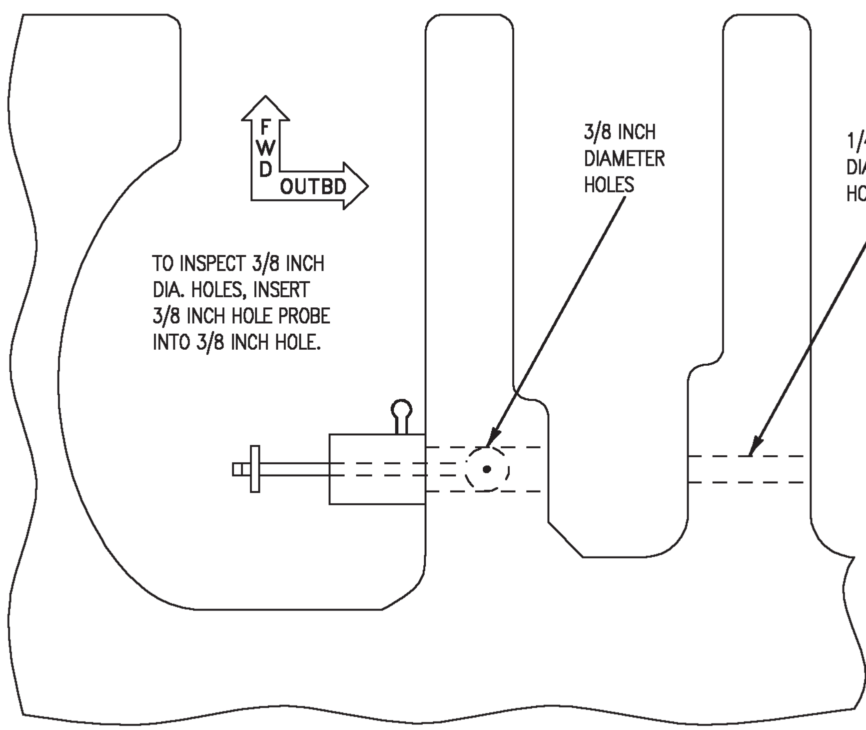


Figure 1. Inspection Areas; 1/4 and 3/8 Inch Diameter Holes Supporting Bolts Inside Roller Bearings (Sheet 1)





C

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Figure 1. Inspection Areas; 1/4 and 3/8 Inch Diameter Holes Supporting Bolts Inside Roller Bearing (Sheet 2)

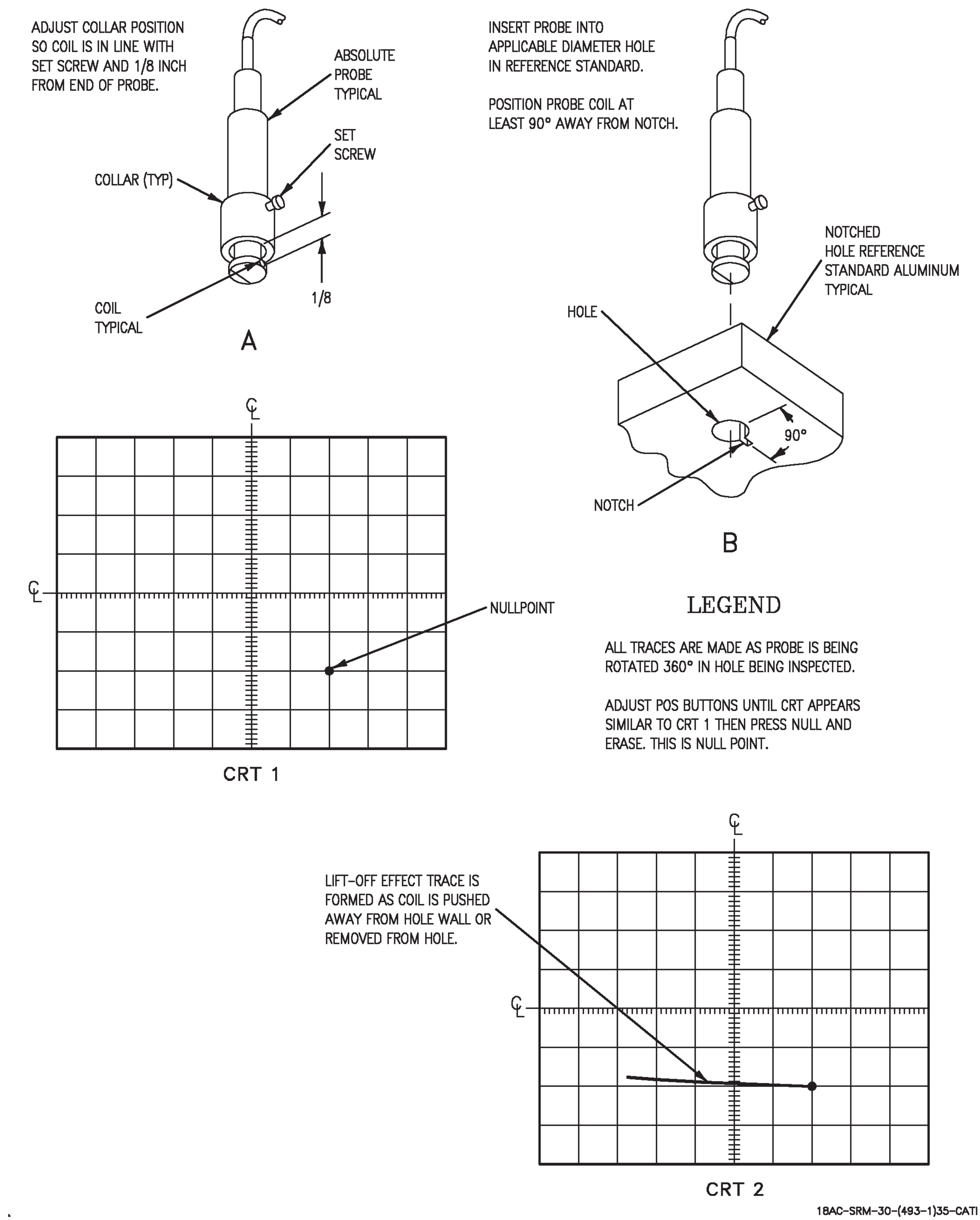


Figure 2. Standardization of NDT-25N (Sheet 1)

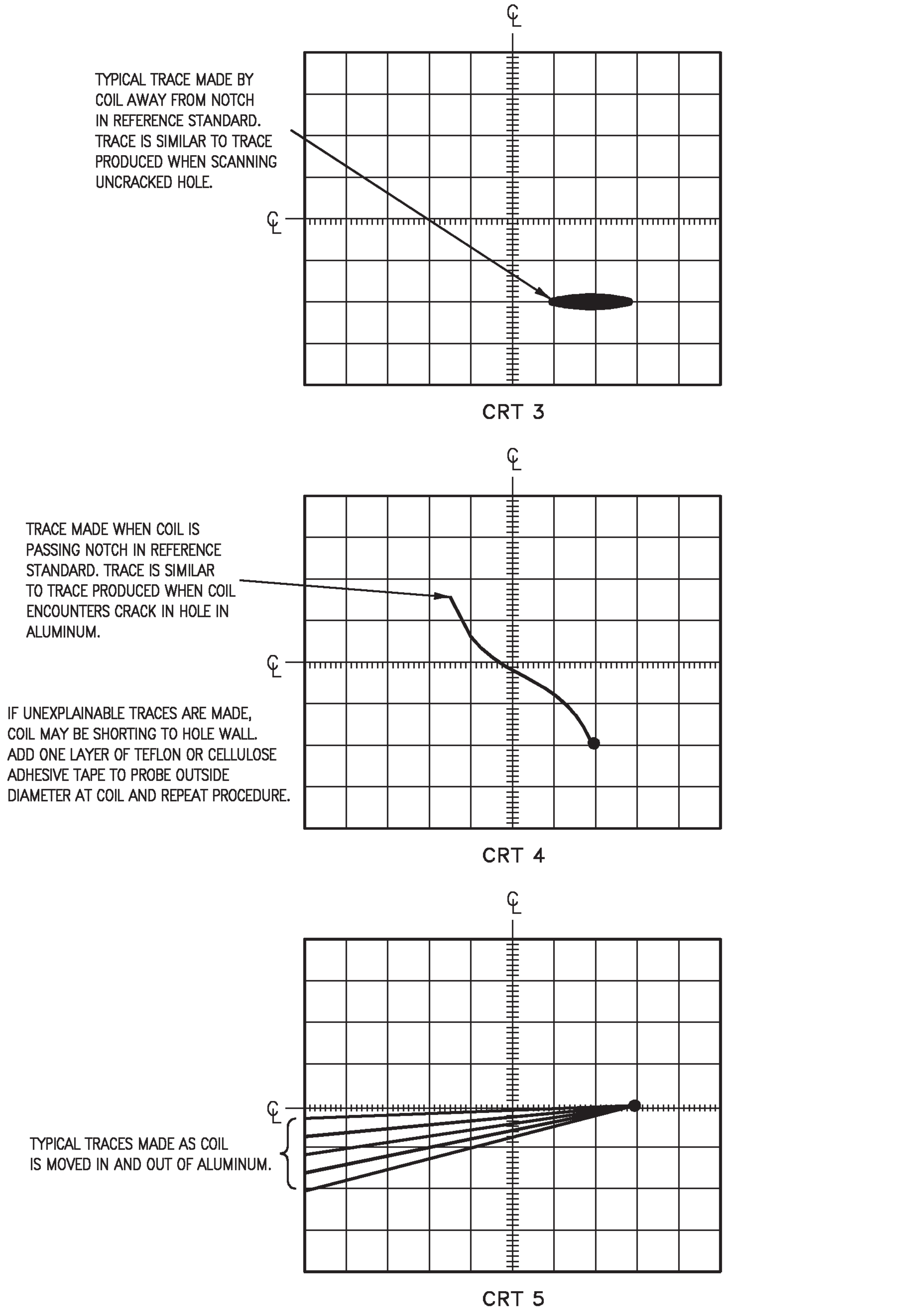
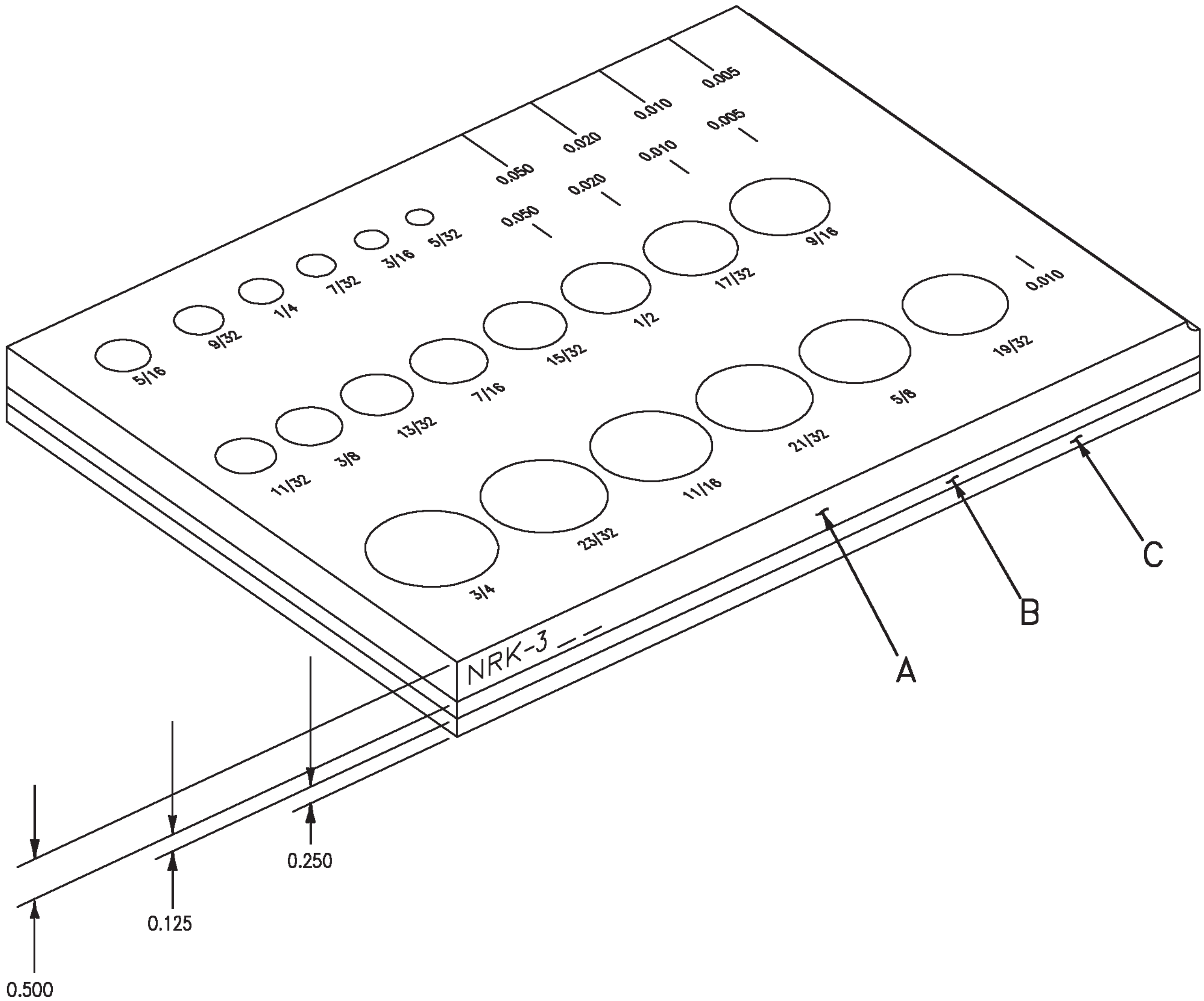


Figure 2. Standardization of NDT-25N (Sheet 2)



NRK-3AST NAVY REFERENCE STANDARD KIT

LAYER	NRK-A3L ALUMINUM	NRK-3TI TITANIUM	NRK-3ST STEEL
A	7075-T73AL	6AL-4V	4340
B	7075-T651AL	6AL-4V	4340
C	7075-T651AL	6AL-4V	4340

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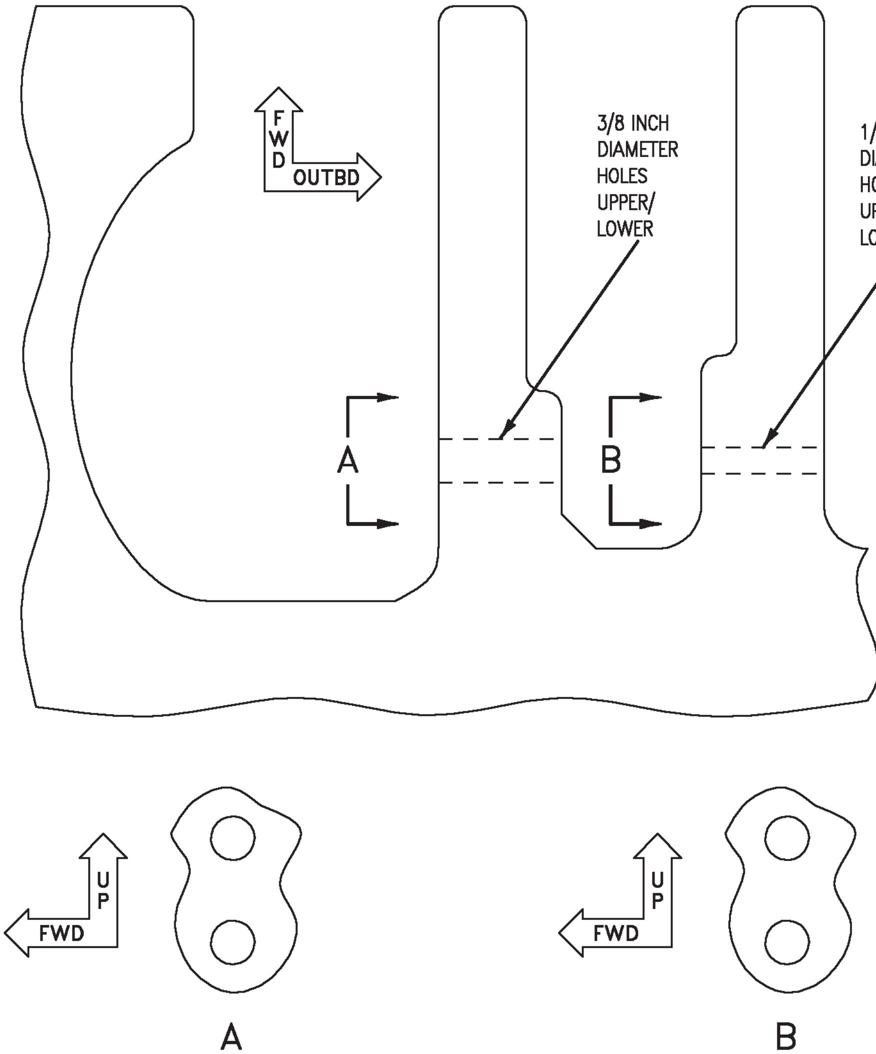
Figure 3. Eddy Current Reference Standard



LOCATION

- ☐ ATSUGI
- ☐ BEAUFORT
- ☐ CECIL FIELD
- ☐ CHINA LAKE
- ☐ EL TORO
- ☐ FALLON
- ☐ IWAKUNI
- ☐ JACKSONVILLE
- ☐ KANEOHE
- ☐ LEMOORE
- ☐ NEW ORLEANS
- ☐ NORTH ISLAND
- ☐ PATUXENT RIVER
- ☐ POINT MUGU
- ☐ YUMA
- ☐ OTHER ______________________

☐ NO CRACK INDICATIONS FOUND

SQUADRON ______________________

BUREAU NO. ______________________

MCAIR CUM NO. ______________________

FLIGHT HOURS ______________________

NO. OF LANDINGS ______________________

INSPECTION DATE ______________________

INSPECTOR ______________________

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Figure 4. Documentation Sheet

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

TRAILING EDGE FLAP OUTBOARD HINGE

This WP supersedes WP014 02, dated 1 July 1997.

Reference Material

Aircraft Corrosion Control	A1-F18AC-SRM-500
Form in Place Sealing	WP010 00
Structure Repair, Wing	A1-F18AC-SRM-210
Trailing Edge Flap, Leading Edge Metal Skins	WP008 01
Integrated Flight Controls	A1-F18AC-570-300
Trailing Edge Flap (84MPU539 OR 84MPU540)	WP039 00
Structure Repair, Wing	A1-F18AE-SRM-600
Trailing Edge Flap, Leading Edge Metal Skins	WP015 00
Structure Repair, General Information	A1-F18AC-SRM-200
Fasteners	WP004 06
Bearing Removal and Installation Tool Set	WP004 38
Naval Aviation Maintenance Program	OPNAVINST 4790.2
NADEP Instructions	12410.25
MIL-STD-410 (AIA/NAS410)	

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No.	Date Incorp.	Remarks
F/A-18 AFB 237 Rev A	-	Trailing Edge Flap Outboard Roller Support Fitting	15 Mar 93	-
F/A-18 AYB 831	-	Trailing Edge Flap, Outboard Hinge, Inspection of	15 Nov 02	-

1. TRAILING EDGE FLAP OUTBOARD HINGE.

2. Trailing edge flap outboard hinge is made from 7050 aluminum forging heat treated to T736 or T73652 depending on dash number, see figure 1, detail B. Finish system is IVD, aluminum, coated, followed by one coat epoxy primer and two coats polyurethane enamel.

3. **DEFECTS.** Inspect for cracks:

a. Forward fillet;

b. Interior surface of bearing housing, see figure 2.

4. **INSPECTION METHOD.** Eddy current.

5. **PERSONNEL QUALIFICATIONS.** One of the following certificates is required:

a. Eddy current level II or III per NADEP NORIS instructions 12410.25, or

b. Eddy current level II or III per MIL-STD-410 or AIA/NAS410, or

c. Navy or Marine NDI Technician (NEC 7225 or MOS 6033) per OPNAVINST 4790.2.

6. **PREPARATION OF AIRCRAFT.** No special preparation required.

7. **ACCESS.**

a. Remove trailing edge flap (A1-F18AC-570-300, WP039 00).

b. Remove P/N 74A180668 grounding strips from outboard hinge by drilling out rivet heads (A1-F18AC-SRM-210, WP008 01 or A1-F18AE-SRM-600, WP015 00).

c. Remove P/N 14103-8 trailing edge flap outboard hinge bearing (A1-F18AC-SRM-200, WP004 38).

Support Equipment Required

Part Number or Type Designation	Nomenclature
HA-1.0/PWNI or Equivalent	Eddy Current Reference Standard, Aluminum, Notched
MBA1-1.0 or Equivalent	Eddy Current Bolt Hole Probe Manual, 1 inch Dia., 200 Khz, Abs Coil Shielded, Split Shaft Microdot Connector
MIZ-20A	Eddy Current, Instrument
MP-30 or Equivalent	Surface Probe, Ferrite Shielded, 3 inch long, 1/8 inch Dia., 200 Khz.
MP-905 or Equivalent	Surface Probe, 1/2 inch Drop Right Angle, Ferrite Shielded, 5 inch long, 1/8 inch Dia., 200 Khz.
NRK-3AST or Equivalent	Eddy Current Reference Standard Set, Aluminum, Notched. NRK-3AL required
PD214 or Equivalent	Eddyscope
PG-74-90-21-001	Probe Guide Assembly
57A2271	Microdot to Bnc Connecting Cable
74D110166-1001	Tool Set, Bearing

Materials Required

Specification or Part Number	Nomenclature
P-D-680 TYII or Equivalent	Solvent, Dry Cleaning
TT-I-735 or Equivalent (CAGE 81348)	Alcohol, Isopropyl
CCC-C-46, TYPE I CLASS 4 (CAGE 81348)	Cloth, Cleaning
TEFLON TAPE	Tape, Electrical Insulating

8. **PREPARATION OF PART.**

a. Remove sealing compound from inspection area(s) as required to complete inspection (A1-F18AC-SRM-500, WP010 00). Do not gouge surface. After removal of sealing compound, make sure surface is smooth and free of abrupt discontinuities, for example, chipped paint or primer. Sand and clean finish system, if required.

WARNING

Dry cleaning solvent may be flammable and/or toxic. Follow safety precautions appropriate to the solvent used. Skin and eye protection may be required. Avoid repeated/prolonged contact.

b. Clean all areas to be inspected with a cleaning cloth moistened with dry cleaning solvent.

c. Visually inspect area(s) for evidence of cracks and accumulation of soot or dirt, see figure 2.

d. If the inspection area surface is rough from dings, dents, or damage; blending may be required to facilitate smooth scanning.

9. **EQUIPMENT SETTINGS/ STANDARDIZATION/ SETUP.**

a. Apply teflon tape to the tip proper/frequency probes from the CGSE Prove kit and connect to the instrument using the dual BNC connector.

Material	Probe Frequency
Aluminum (Al)	200 kHz

b. Turn on power switch and allow detector to complete self-test routines.

c. Adjust **BRT** control to get desired display of brightness.

d. Press **ENTER** on keypad and flaw detector menu black highlight will appear.

e. Using down-left arrow on keypad to move black highlight and **SMART KNOB**, set each of the instrument's menu elements for the material to be inspected as below:

Element	Material
	Aluminum
GAIN*	43 dB
FREQ	200 Khz
DISPLAY	H-V
ERASE*	MANUAL
H	0.4 V/D
V	0.2 V/D
H-POS	0.D
V-POS	0.D
FILTER#	OFF
ALARM	OFF
PROBE (DRIVE) #	4.0 V
PROBE (TYPE) #	ABS/DIFF

* The asterisk marked items may be adjusted by the inspector as required.

To adjust the pound marked settings, press **ENTER** on keypad to enter the function, adjust as required and press **ERASE** to return to menu.

f. Position the inspection probe on the respective standard for the NRK-3AST kit away from all flaws. Press **NULL** on keypad to start test and press **NULL** on keypad a second time to balance detector.

g. Lift probe off the standard or from the hole and press **AUTO LIFE OFF** on keypad, place probe back on the standard or in the hole, then lift it off to verify the lift off signal follows the baseline from right to left.

h. Position probe back on the respective standard and press **ERASE** on keypad, scan probe over the 0.020 inch X 1.000 inch and the 0.050 inch X 1.000 inch EDM notches of the standard. See figure 3 for representation CRT scans. Adjust **GAIN** as required to get a vertical deflection of two major screen divisions from the 0.020 inch EDM notch.

i. Position inspection probe on the NRK-3AL standard from NRK-AST kit away from all flaws. Press **NULL** on keypad to start. Press **NULL** on keypad a second time to balance detector.

j. For lug hole inspection, position the MBA1-1.0 eddy current bolt hole probe into the HA-1.0/PWNI eddy current standard, away from EDM notch and repeat steps (g) and (h).

10. **INSPECTION PROCEDURE.**

a. Visually look at the surfaces to be inspected using a flashlight and mirror if required. Report and document any cracks observed by the visual inspection.

b. Make sure all foreign matter (grease, oil, and dirt, etc.) has been removed from the inspection areas.

c. If an inspection procedure is not specified, select probes that will provide enough access to the particular scan area and have frequency corresponding to the particular material, see step a in paragraph Equipment Settings/ Standardization/ Setup, this WP.

d. Null the detector to the test area and scan the whole test area in two perpendicular directions, indexing the probe in 1/8 inch increments with a scanning speed of no greater than 1.5 inch per second.

11. **EVALUATION PROCEDURE.**

a. If accept/reject criteria is not specified, sharp vertical deflections equal to or greater than the reference standard EDM notch (0.010 inch) indication shall be noted as cause for rejection.

12. **ACCEPTANCE LIMITS.** Request outboard hinge replacement per AYC 1137 for all crack indications on trailing edge flaps with less than 5000 component flight hours. Trailing edge flaps with more than 5000 component flight hours having crack indication will request engineering disposition.

13. **DOCUMENTATION.**

a. If no cracks are found, record this inspection in aircraft logbook and component SRC card as completed.

b. If crack(s) are found, map location and provide dimensions on illustration given in figure 4. Include information, for example, aircraft bureau number, total aircraft flight hours, total component flight hours, accessory bulletin number, date of inspection, and clearly printed name of inspector.

c. Submit documentation sheet to local engineering for disposition. File one copy of documentation sheet and engineering disposition in aircraft logbook and provide to Boeing representative.

14. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Dry cleaning solvent may be flammable and/or toxic. Follow safety precautions appropriate to the solvent used. Skin and eye protection may be required. Avoid repeated/prolonged contact.

a. Clean inspection area(s) with cloth moistened with dry cleaning solvent.

b. Allow to air dry for 15 minutes after cleaning.

15. **SYSTEM SECURING.**

a. Install P/N 14103-8 trailing edge flap outboard hinge bearing (A1-F18AC-SRM-200, WP004 38).

b. Install P/N 74A180668 grounding strips, see figure 1 (A1-F18AC-SRM-210, WP008 01 or A1-F18AE-SRM-600, WP015 00).

c. Install trailing edge flap (A1-F18AC-570-300, WP039 00).

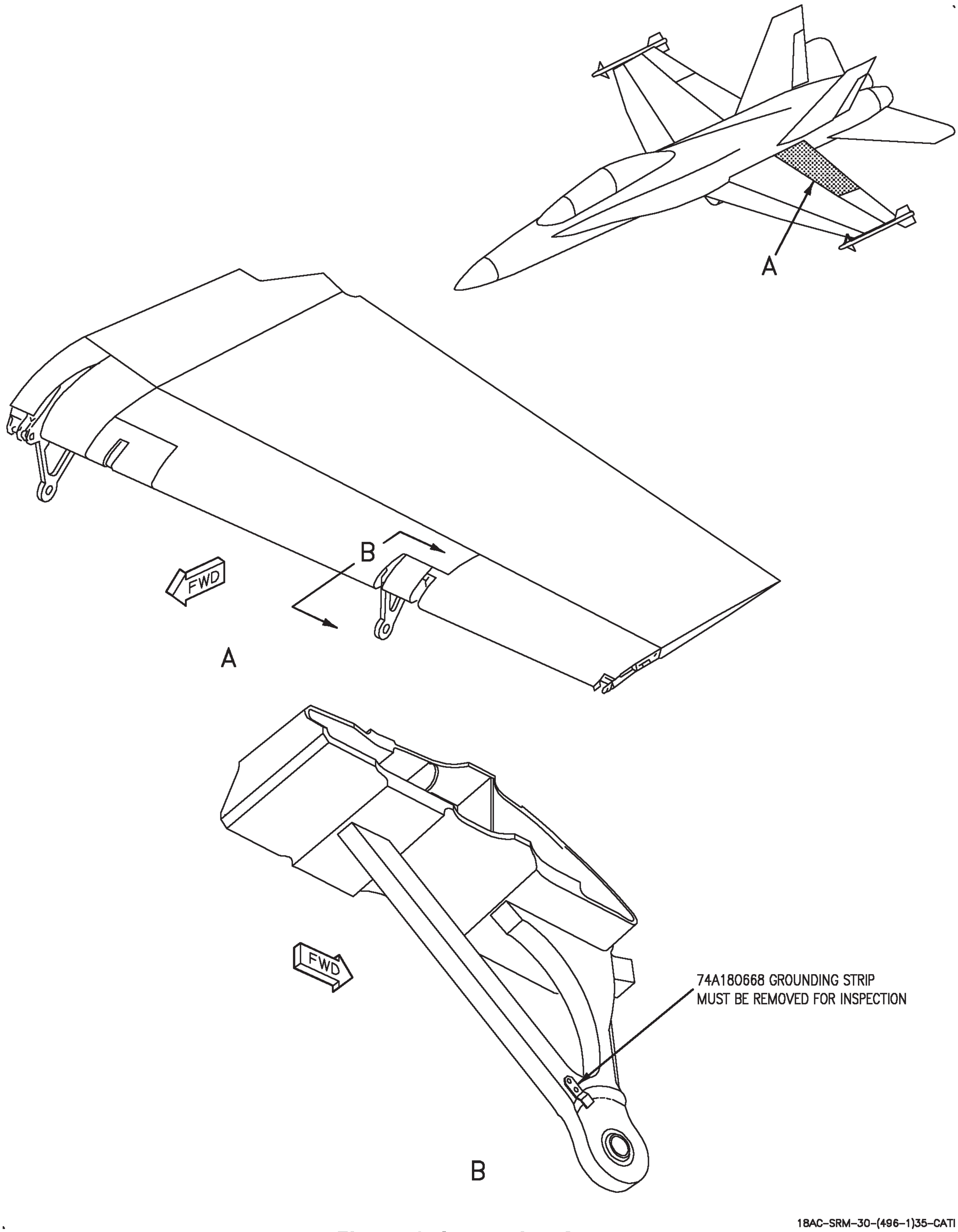


Figure 1. Inspection Areas

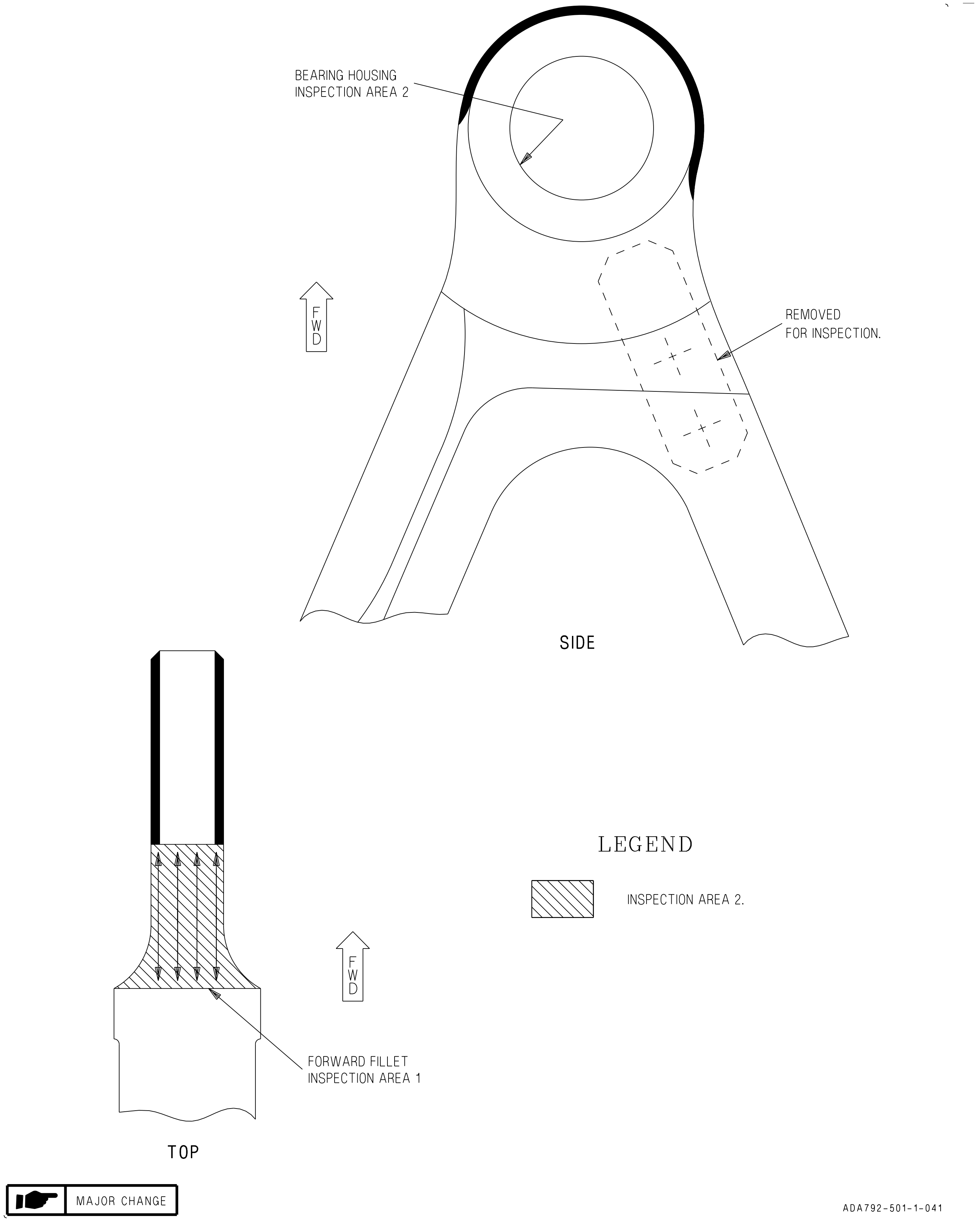


Figure 2. Inspection Areas

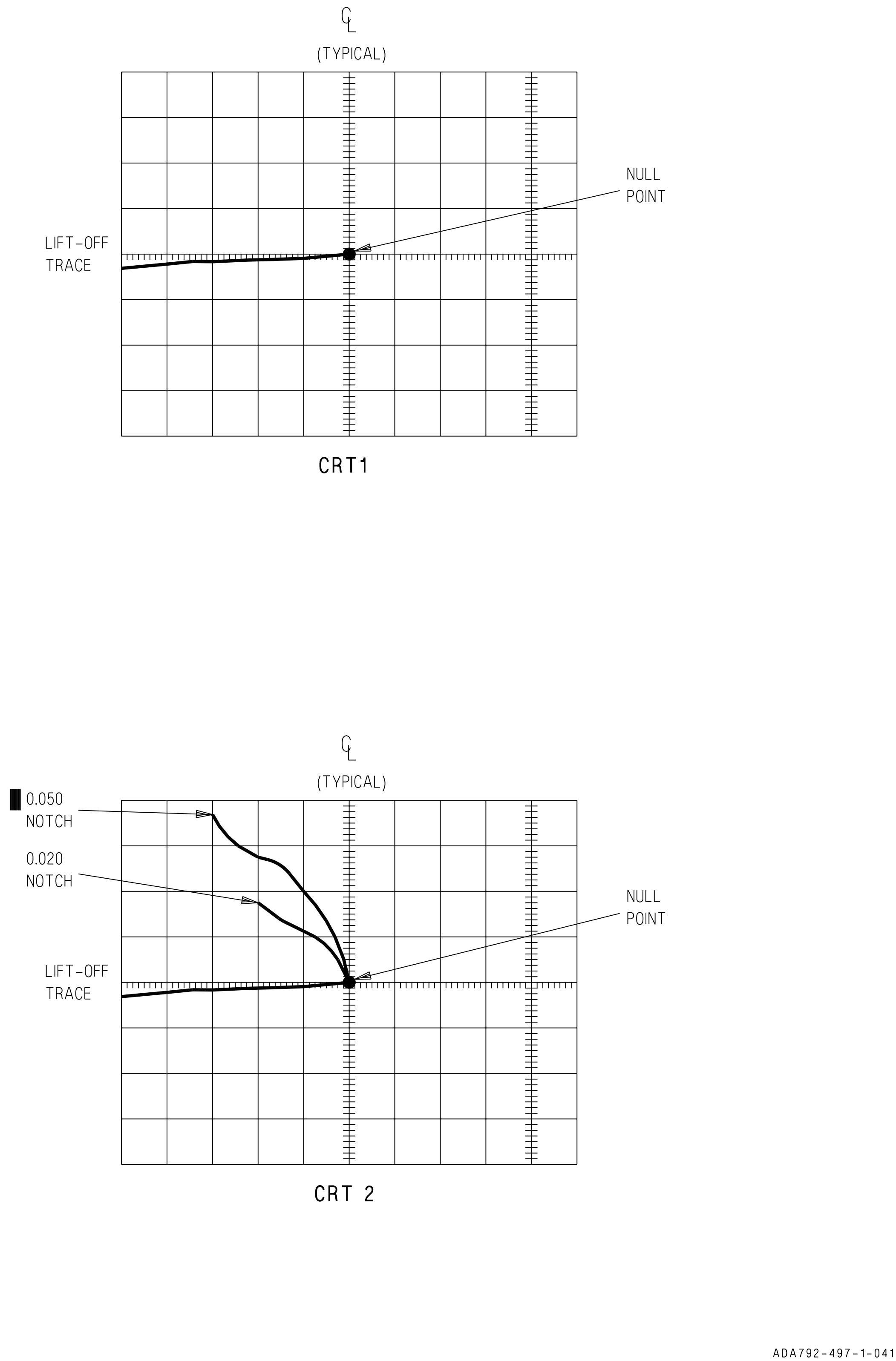
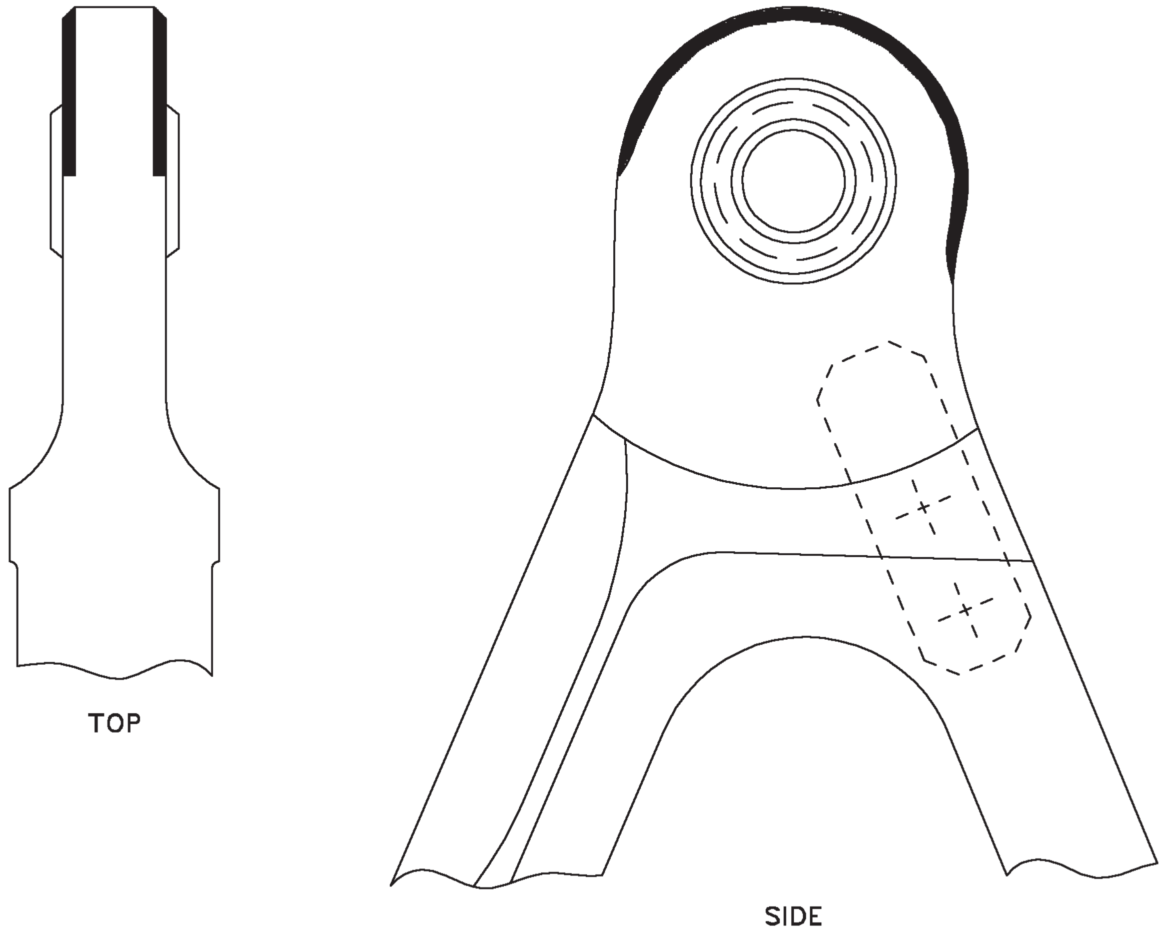


Figure 3. Eddy Current CRT Presentations



LOCATION

- ☐ ATSUGI
- ☐ BEAUFORT
- ☐ CECIL FIELD
- ☐ CHINA LAKE
- ☐ EL TORO
- ☐ FALLON
- ☐ IWAKUNI
- ☐ JACKSONVILLE
- ☐ KANEOHE
- ☐ LEMOORE
- ☐ NEW ORLEANS
- ☐ NORTH ISLAND
- ☐ PATUXENT RIVER
- ☐ POINT MUGU
- ☐ YUMA
- ☐ OTHER ____________

- ☐ LH FLAP
- ☐ RH FLAP
- ☐ NO CRACK INDICATIONS FOUND

SQUADRON ____________

BUREAU NO. ____________

MCAIR CUM NO. ____________

FLIGHT HOURS ____________

NO. OF LANDINGS ____________

INSPECTION DATE ____________

INSPECTOR ____________

18AC–SRM–30–(505–1)35–CATI

Figure 4. Documentation Sheet

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

TRAILING EDGE FLAP SHROUD HINGES

This WP supersedes WP014 03, dated 15 March 1993.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Aircraft Corrosion Control	A1-F18AC-SRM-500
Form in Place Sealing	WP010 00
Structure Repair, Wing	A1-F18AC-SRM-211
Trailing Edge Flap, Leading Edge Metal Skins	WP007 00
Structure Repair, Wing	A1-F18AE-SRM-600
Trailing Edge Flap, Leading Edge Metal Skins	WP013 00

Alphabetical Index

Record of Applicable Technical Directives

Type/ Number	Date	Title and ECP No.	Date Incorp.	Remarks
F/A-18 AFB 237 Rev A	-	Trailing Edge Flap Outboard Roller Support Fitting	15 March 93	-

1. TRAILING EDGE FLAP SHROUD HINGES.

2. Trailing edge flap shroud hinges, see figure 1, are made as follows;

74A1110631	7050	Al Aly
74A110705 or 74A110989	7075	Al Aly
74A110988	7075	Al Aly
74A110955	6AL-4V Ti	

Finish system is anodize, one coat epoxy primer, and two coats polyurethane enamel, except for 74A110955 which has one coat epoxy primer and two coats polyurethane enamel.

3. **DEFECTS.** Inspect for cracked hinges, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per

OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044..

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have trailing edge flap shroud removed (A1-F18AC-SRM-211, WP007 00 or A1-F18AE-SRM-600, WP013 00)

NOTE

Reference standard is considered equivalent for this inspection if made of same base material and contains at least two electrical discharge machined (EDM) notches between 0.008 and 0.040 deep.

Any impedance plane eddy current equipment may be used for this procedure along with any probe, provided equipment and probe are standardized similar to paragraphs 9 and 11.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT-25N	Programmable Eddysscope, Nortec, MXU-713/E
9505955	NDT-25N Accessory Kit
NRK-3AST	Navy Reference Standard Kit
1RR90F-6-1/2 OR EQUIVALENT	Ferrite Shielded, 1/8 Inch Dia, 6 Inches Long, 200 KHz, 1/2 Inch Drop Right Angle Surface Probe
1RR90F-6-1/2 1M/16L or EQUIVALENT	Ferrite Shielded, 1/8 Inch Dia, 6 Inches Long, 1 KHz, 1/2 Inch Drop Right Angle Surface Probe
1RR90F-6-1/8 1M/16L OR EQUIVALENT	Ferrite Shielded, 1/8 Inch Dia, 6 Inches Long, 1 KHz, 1/8 Inch Drop Right Angle Surface Probe

Support Equipment Required

Part Number or Type Designation	Nomenclature
57A2271	Microdot to BNC Connecting Cable, Two Reqd

Materials Required

Specification or Part Number	Nomenclature
020X413	Cleaning Compound
COMMERCIAL	Tube Type Marker
CCC-C-46, TYPE I CLASS 4	Cleaning Cloth
COMMERCIAL	Teflon Tape
A-A-1047 GRIT 240 -9 X 11	Abrasive Paper

8. **Preparation of Part.**

a. Locate inspection area(s), see figure 1.

b. Have sealant removed from sides of hinges to provide smooth inspection surface (A1-F18AC-SRM-500, WP010 00. Do not gouge surface. After removal of sealant, make sure surface is smooth and free of abrupt discontinities such as chipped paint or primer. Have finish system sanded and cleaned, if required.

c. Visually inspect inspection area(s) for evidence of cracks. Cracked area(s) may show accumulation of dirt or soot.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

d. Clean inspection area(s)with cleaning compound moistened cloth.

e. Allow to air dry for 15 minutes after cleaning.

9. **Equipment Settings/Standardization/Setup, 74A110631, 74A110705 or 74A110989, 74A110988 Hinges.**

a. Attach ADN-B1 adapter, which is part of the NDT-25N accessory kit, to NDT-25N programmable eddyscope (tester).

b. Attach two 57A2271 microdot to BNC connecting cables to adapter.

c. Attach 1RR90F-6-1/2 surface probe being used for inspection to cable attached to front of adapter.

d. Attach another, like, probe to cable connected to side of adapter. Probe connected to side of adapter is used as reference coil and must be kept away from electrically conductive material.

e. Set tester front face settings;

POWER..........................	ON
STATUS LIGHTS	ON
GAIN	30
FREQ..............................	190
FILTER..........................	0
H SENS..........................	1
V SENS	0.2
DISPLAY........................	H/V
I/O SWITCHES............	OFF
ALARM..........................	OFF
NON-STORE	OFF

f. Press NULL and ERASE buttons.

g. Position probe on NRK-3AL reference standard, which is part of the Navy reference standard kit.

h. Keep probe tip normal to surface and away from edges, notches, or holes.

i. Press NULL and ERASE buttons.

j. Use POS buttons to set flying dot at position shown on figure 2, CRT 1. This is NULL position.

k. Lift probe off reference standard. This is lift-off trace. This trace should be similar to trace shown on figure 2, CRT 1. If not, adjust ANGLE and GAIN to get this response.

NOTE

If erratic indications occur on CRT, probe may be shorting against reference standard surface. Either replace probe or apply teflon tape to probe end.

l. Scan probe perpendicular over 0.015 to 0.000 and 0.030 to 0.000 surface notches 0.125 from edge of reference standard. Trace responses similar to those shown in figure 2, CRT 2, will be produced.

10. **Inspection Procedure, 74A110631, 74A110705 or 74A110989, 74A110988 Hinges.**

a. Place probe against surface of hinge being inspected making sure it is normal to surface.

b. Press NULL and ERASE buttons.

c. Press POS buttons to position dot as shown on figure 2, CRT 1, NULL position.

d. Lift probe guide from hinge perpendicular to hinge surface. Adjust ANGLE and GAIN to get lift-off response similar to figure 2, CRT 1.

e. Scan both sides of inspection area(s), first in forward and aft direction and then top to bottom direction, so each side of each hinge is scanned twice. Index 1/16 inch after each scan pass.

f. Responses of similar phase angle and greater in magnitude than that of 0.015 notch shown in figure 2, CRT 2, indicate crack. Determine length of crack by sliding right angle surface probe perpendicular across crack. If response still occurs, move probe 1/16 inch parallel to crack and scan again. Crack end is determined when trace is not produced when probe is scanned in region of crack. Mark length of all indications.

11. **Equipment Settings/Standardization/Setup, 74A110955 Hinge.**

a. Replace 1RR90F-6-1/2 probes with 1RR90F-6-1/2 1M/16L and 1RR90F-6-1/8 1M/16L probes.

b. Set tester front face settings;

POWER..........................	ON

STATUS LIGHTS	ON
GAIN	44
FREQ..............................	1000
FILTER..........................	0
H SENS..........................	1
V SENS	0.2
DISPLAY........................	H/V
I/O SWITCHES............	OFF
ALARM..........................	OFF
NON-STORE	OFF

c. Press NULL and ERASE buttons.

d. Position probe on NRK-3T1 reference standard, which is part of the Navy reference standard kit. Keep probe normal to surface and away from edges, notches, or holes.

e. Press NULL and ERASE buttons.

f. Use POS buttons to set flying dot at position shown on figure 2, CRT 1. This is NULL position.

g. Lift probe off reference standard. This is lift-off trace. This trace should be similar to trace shown on figure 2, CRT 1. If not, adjust ANGLE and GAIN to get this response.

NOTE

If erratic indications occur on CRT of NDT-25N, probe may be shorting against reference standard surface. Either replace probe or apply teflon tape to probe end.

h. Scan probe perpendicular over 0.010 to 0.0 and 0.020 to 0.000 tapered surface notches 0.125 from edge of reference standard. Trace responses similar to those shown in figure 2, CRT 2, will be produced.

12. **Inspection Procedure, 74A110955 Hinge**

a. Position probe on surface of hinge, see figure 3, making sure probe is perpendicular to inspection surface(s).

b. Press NULL and ERASE buttons.

c. Use POS buttons to position flying dot at NULL position shown in figure 2, CRT 1.

d. Press NULL and ERASE.

e. Lift probe off hinge surface in direction perpendicular to hinge surface.

f. Adjust ANGLE and GAIN to get lift-off trace similar to figure 2, CRT 1.

g. Scan both sides of inspection area for one of two lugs, first in forward and aft direction and then in top to bottom direction so each side of each lug is scanned twice. Index 1/16 inch after each scan pass.

NOTE

It will be required to use 1/8 inch drop probe for inspecting between two lugs of hinge.

h. Any response of similar phase angle and greater magnitude than that for 0.010 notch shown in figure 2, CRT 2, indicate crack.

i. Determine crack length by sliding probe perpendicular across crack. If response still occurs, move probe 1/16 inch parallel to crack and scan again. Crack end is determined when trace is not produced when probe is scanned in region of crack. Mark length of all indications.

j. Repeat steps g. and h. for both lugs of hinge

13. **Acceptance limits.** Request engineering disposition for all crack indications.

14. **Documentation.**

a. If no cracks are found, record this inspection in aircraft log book as completed.

b. If cracks are found, map location and provide dimensions on illustration similar to figure 3. Include information such as aircraft bureau number, total flight hours, airframe change number, date of inspection, and printed name of inspector.

c. Submit documentation sheet to local engineering for disposition. File one copy of documentation sheet and engineering disposition in aircraft log book, and provide local MCAIR representative with copy.

WARNING

Cleaning compound is flammable liquid and vapor. May cause allergic respiratory and skin reaction. May cause eye, skin and respiratory irritation. Keep away from heat, sparks, and flame. Do not breathe dust (vapor, mist, gas). Use only with adequate ventilation. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

15. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection area(s) with cleaning compound moistened cloth.

a. Allow to air dry for 15 minutes after cleaning.

16. **SYSTEM SECURING.**

a. Have trailing edge flap shroud reinstalled (A1-F18AC-SRM-211, WP007 00 or A1-F18AE-SRM-600, WP013 00).

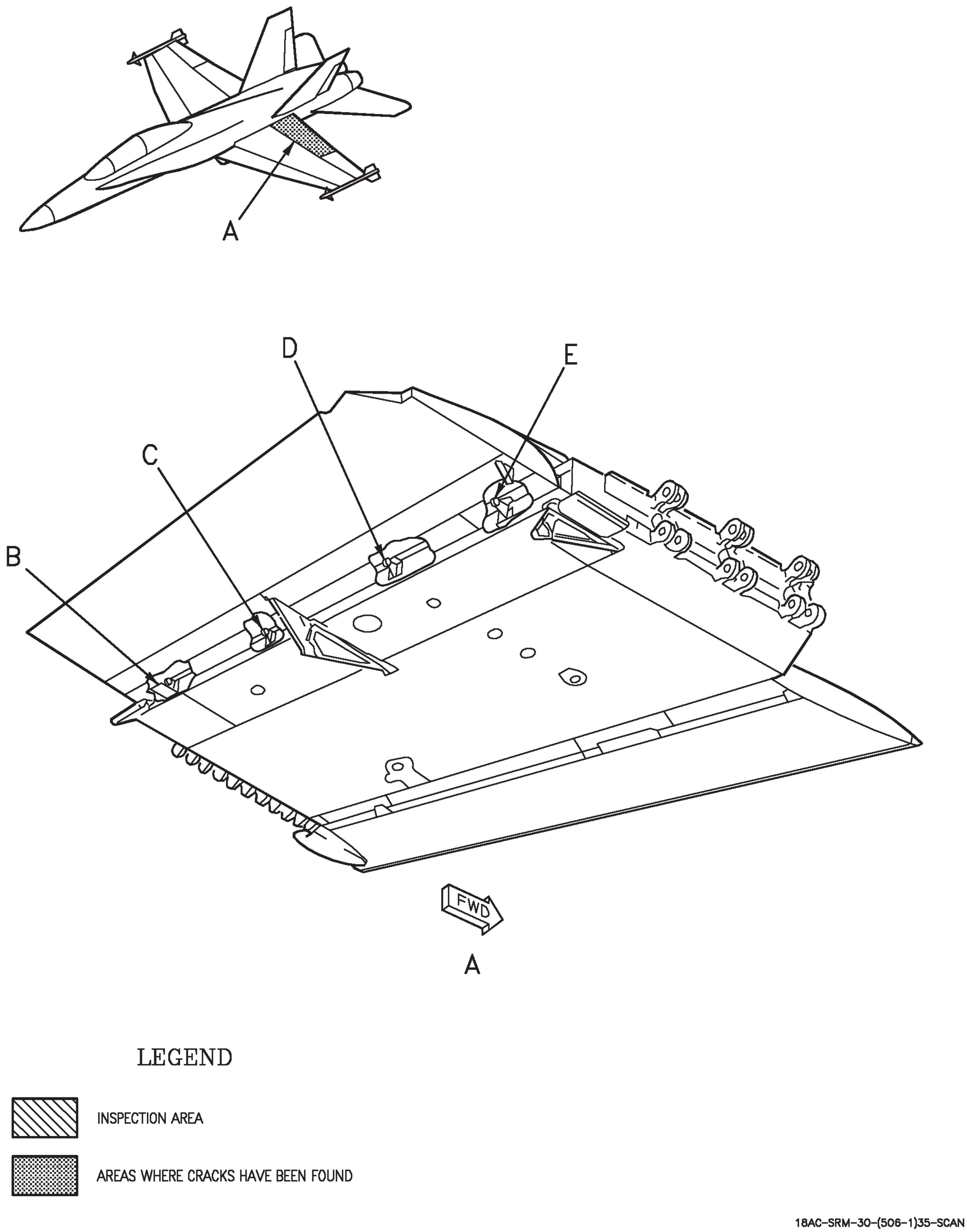
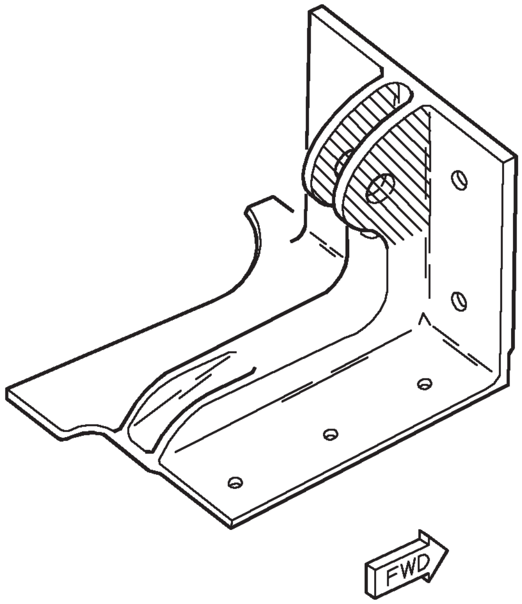
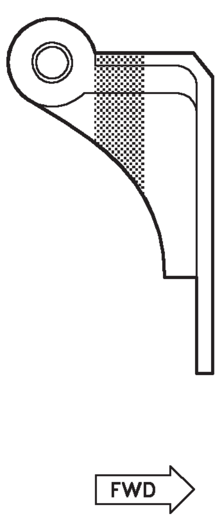


Figure 1. Inspection Areas (Sheet 1)



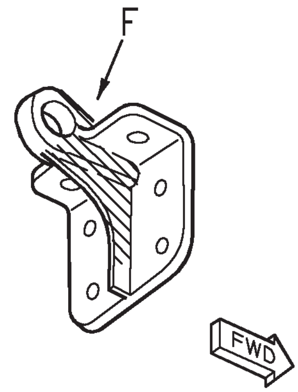
74A110955

B



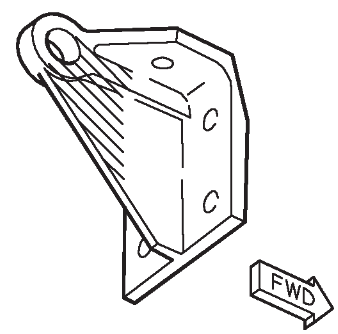
74A110631

F



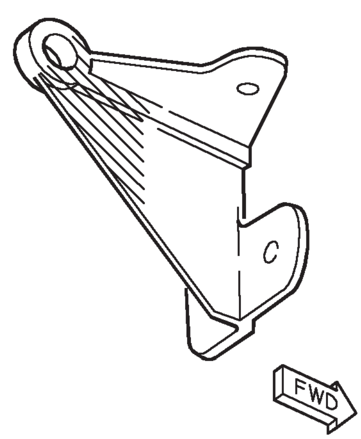
74A110631

C



74A110705
OR
74A110789

D

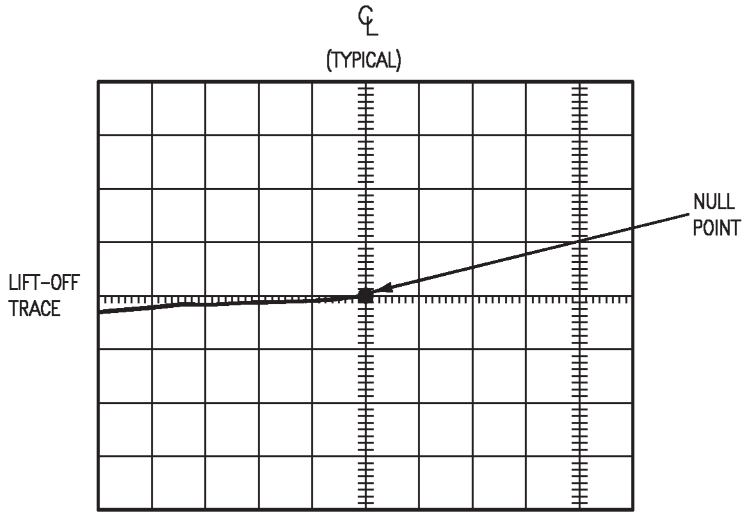


74A110988

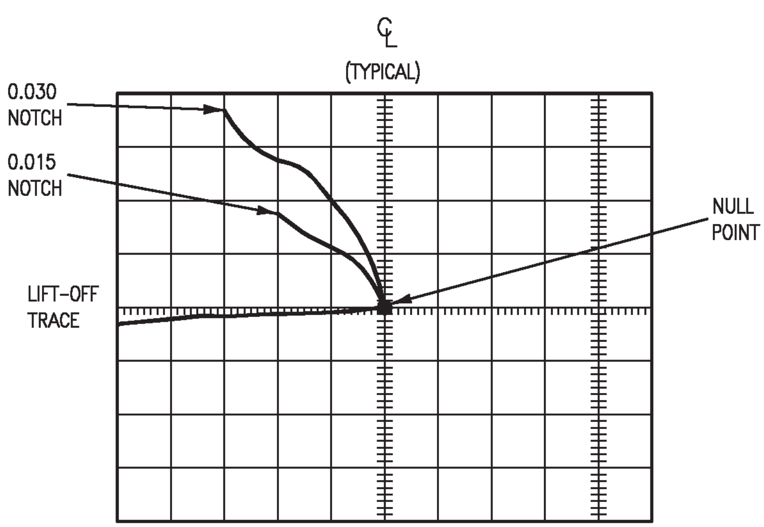
E

18AC-SRM-30-(506-2)35-SCAN

Figure 1. Inspection Areas (Sheet 2)



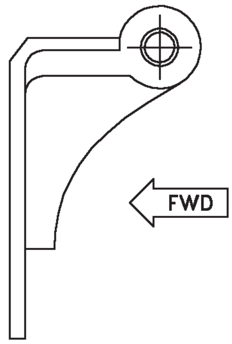
CRT1



CRT 2

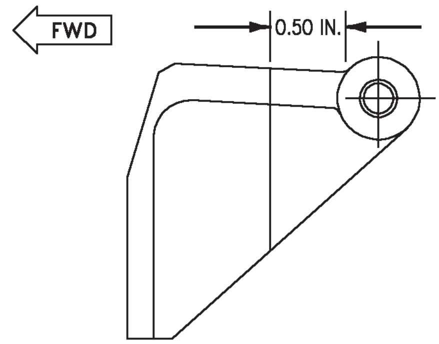
18AC–SRM–30–(507–1)35–CATI

Figure 2. Eddy Current CRT Responses



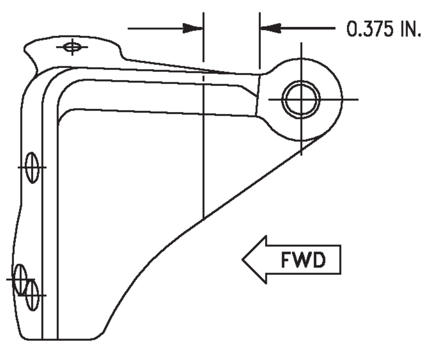
74A110631

LEFT SHOWN
RIGHT OPPOSITE



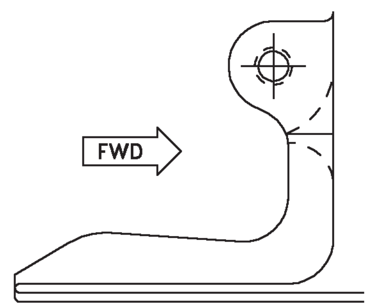
74A110705

LEFT SHOWN
RIGHT OPPOSITE



74A110988

LEFT SHOWN
RIGHT OPPOSITE



74A110955

LEFT SHOWN
RIGHT OPPOSITE

LOCATION

☐ ATSUGI
☐ BEAUFORT
☐ CECIL FIELD
☐ CHINA LAKE
☐ EL TORO
☐ FALLON
☐ IWAKUNI
☐ JACKSONVILLE
☐ KANEOHE
☐ LEMOORE
☐ NEW ORLEANS
☐ NORTH ISLAND
☐ PATUXENT RIVER
☐ POINT MUGU
☐ YUMA

☐ OTHER ______________________

☐ NO CRACK INDICATIONS FOUND

SQUADRON ______________________

BUREAU NO. ______________________

MCAIR CUM NO. ______________________

FLIGHT HOURS ______________________

NO. OF LANDINGS ______________________

INSPECTION DATE ______________________

INSPECTOR ______________________

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Figure 3. Documentation Sheet

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

FLAP SHROUD

WATER IN HONEYCOMB

PART NO. 74A180102

Reference Material

Structure Repair, Wing	A1-F18AC-SRM-210
Flap Shroud	WP007 00
Structure Repair, Wing	A1-F18AE-SRM-600
Trailing Edge Flap Shroud	WP013 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiography	WP005 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **FLAP SHROUD.**

2. Flap shroud is bonded honeycomb assembly. Honeycomb core is 0.125 and 0.188 hexagonal cell, 5056 aluminum alloy. Skin and structure enclosing honeycomb core is 7075 aluminum. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX M FILM CODE M-2 or INDUSTREXAA FILM CODE 14X17	Radiographic Film, X-ray Film 14 x 17
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have flap shroud removed (A1-F18AC-SRM-210, WP007 00 or A1-F18AE-SRM-600, WP013 00).

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per data contained in technique chart, see figure 1.

10. **Inspection Procedure.**

NOTE

X-ray film for shots are double loaded. AA film is located next to the part and both films exposed simultaneously.

a. Locate films 1 and 2 for shot 1. Film should be taped to upper surface of flap shroud with identification markers taped to source side of film pack and penetrameters taped on source side of flap shroud.

b. Locate source to aiming point for shot 1. Source should be normal to aiming point.

c. Expose films 1 and 2 using technique chart settings for shot 1. Remove exposed films from flap shroud.

d. Repeat steps a through c for films 3 and 4 and shot 2.

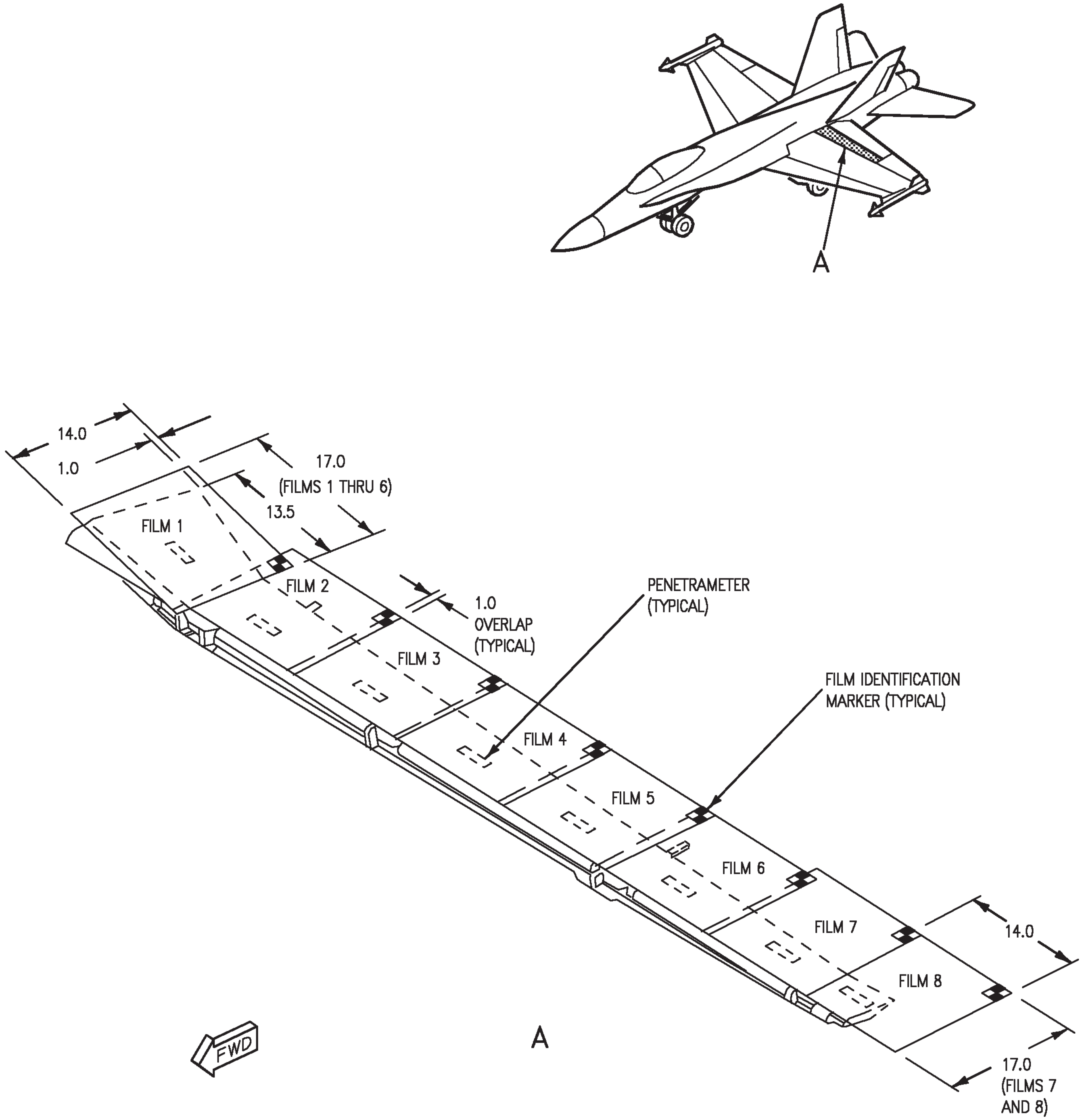
e. Repeat steps a through c for films 5 and 6 and shot 3.

f. Repeat steps a through c for films 7 and 8 and shot 4.

g. Process exposed films. Interpret radiographs for water trapped in honeycomb core (WP005 00).

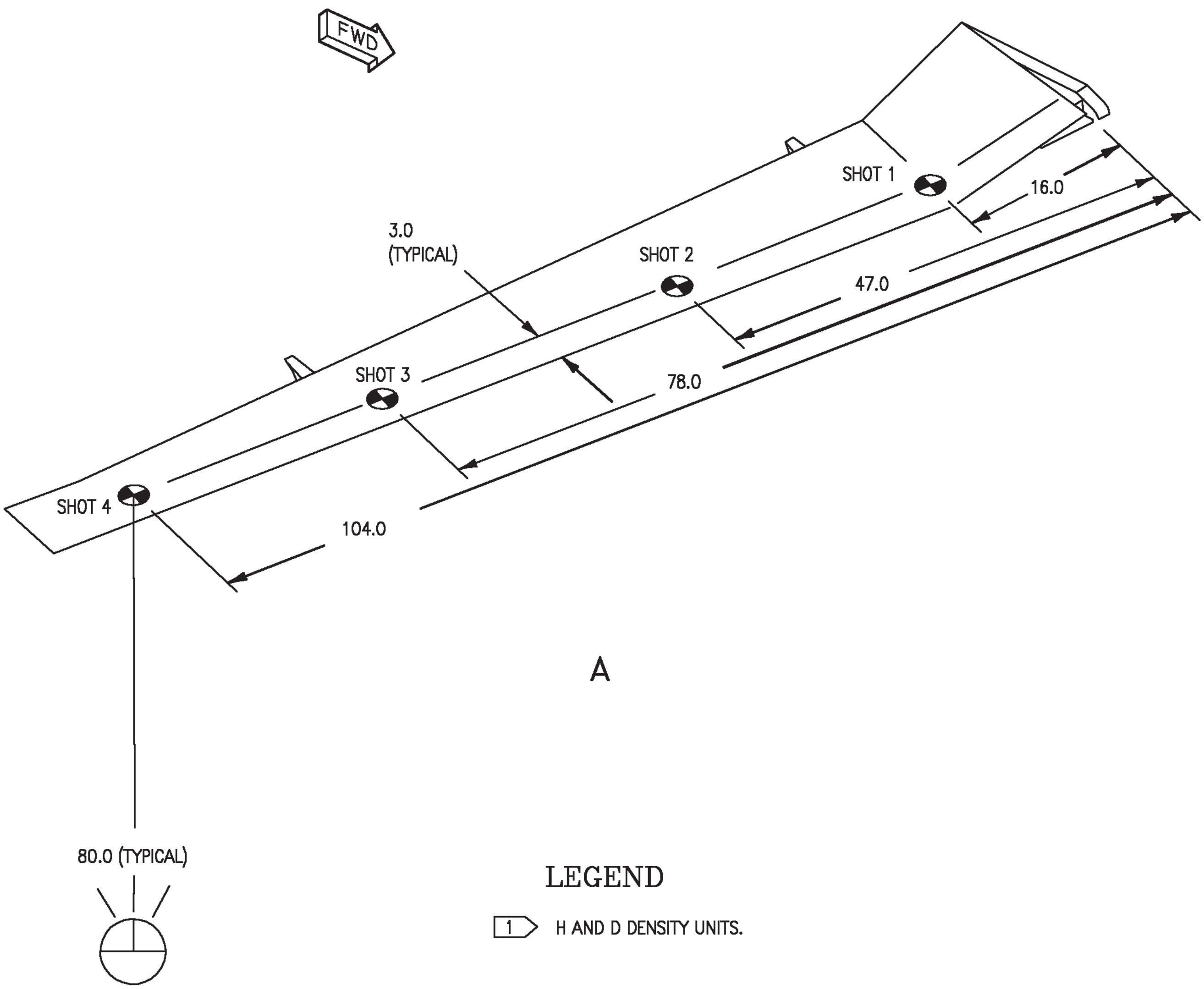
h. Mark defect(s) using an aircraft marking pencil.

11. **SYSTEM SECURING.** Have good flap shroud installed (A1-F18AC-SRM-210, WP007 00 or A1-F18AE-SRM-600, WP013 00).



18AC-SRM-30-(107-1)34-SCAN

Figure 1. Flap Shroud, Water in Honeycomb (Sheet 1)



LEGEND

1 H AND D DENSITY UNITS.

TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1 THRU 4	14 X 17	AA AND M	NO	0.25 AL	2.5	60	3	1.0 - 3.0

18AC-SRM-30-(107-2)34-SCAN

Figure 1. Flap Shroud, Water in Honeycomb (Sheet 2)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

INBOARD FLAP

WATER IN HONEYCOMB

PART NO. 74A190002

Reference Material

Nondestructive Inspection Methods	NAVAIR 01-1A-16
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiography	WP005 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INBOARD FLAP.**

2. Inboard flap is bonded honeycomb assembly. Honeycomb core is 0.125, 0.156 and 0.188 hexagonal cell, 5056 aluminum alloy. Skins are 7075 aluminum alloy. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX M FILM CODE M-2 or INDUSTREXAA FILMCODE14X17	Radiographic Film, X-ray Film 14 x 17
MIL-P-83953-2, TYPE 1 CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions contained in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per data contained in technique chart, see figure 1.

10. **Inspection Procedure.**

NOTE

X-ray film for shots 1 through 4, 9, and 10 are double loaded. AA film is located next to the part and both films are exposed simultaneously.

a. Locate films 1 and 2 for shot 1. Film should be taped to upper surface of the flap with identification markers taped on source side of part or source side of film pack and penetrameters taped to source side of part.

b. Locate source to aiming point for shot 1. Source should be normal to aiming point.

c. Expose films 1 and 2 using technique chart settings for shot 1. Remove exposed film.

d. Repeat steps a through c for films 3 through 8 and shot 2 through 7.

e. Repeat steps a through c for films 9 and 10 and shots 8 and 9.

f. Repeat steps a through c for films 11 and 12 and shot 10.

g. Repeat steps a through c for films 13 and 14 and shot 11.

h. Repeat steps a through c for films 15 and 16 and shots 12 and 13.

i. Repeat steps a through c for films 17 and 18 and shots 14 and 15.

j. Process exposed film. Interpret radiographs for water trapped in honeycomb core, (WP005 00).

k. Mark defect(s) using aircraft marking pencil.

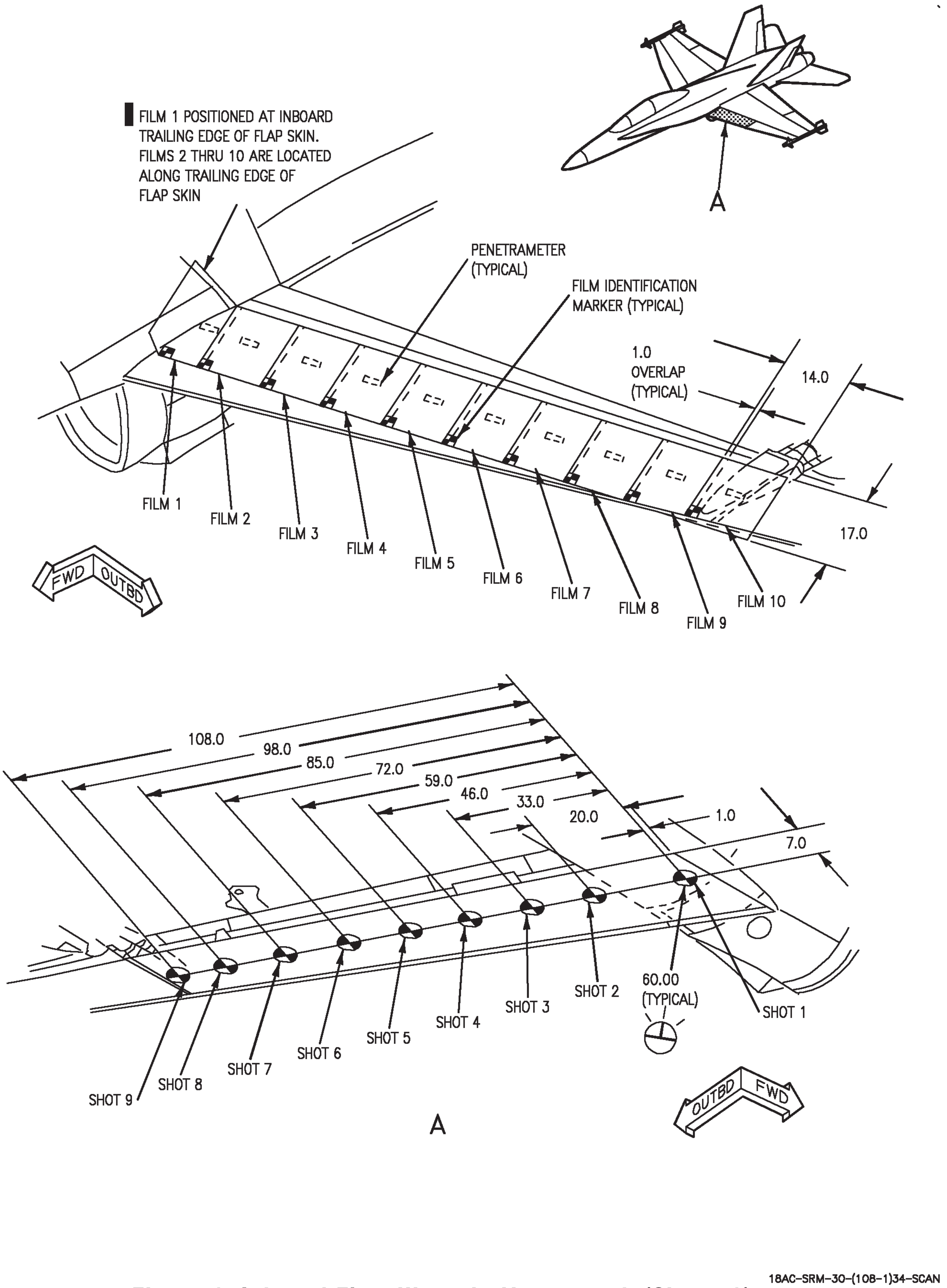
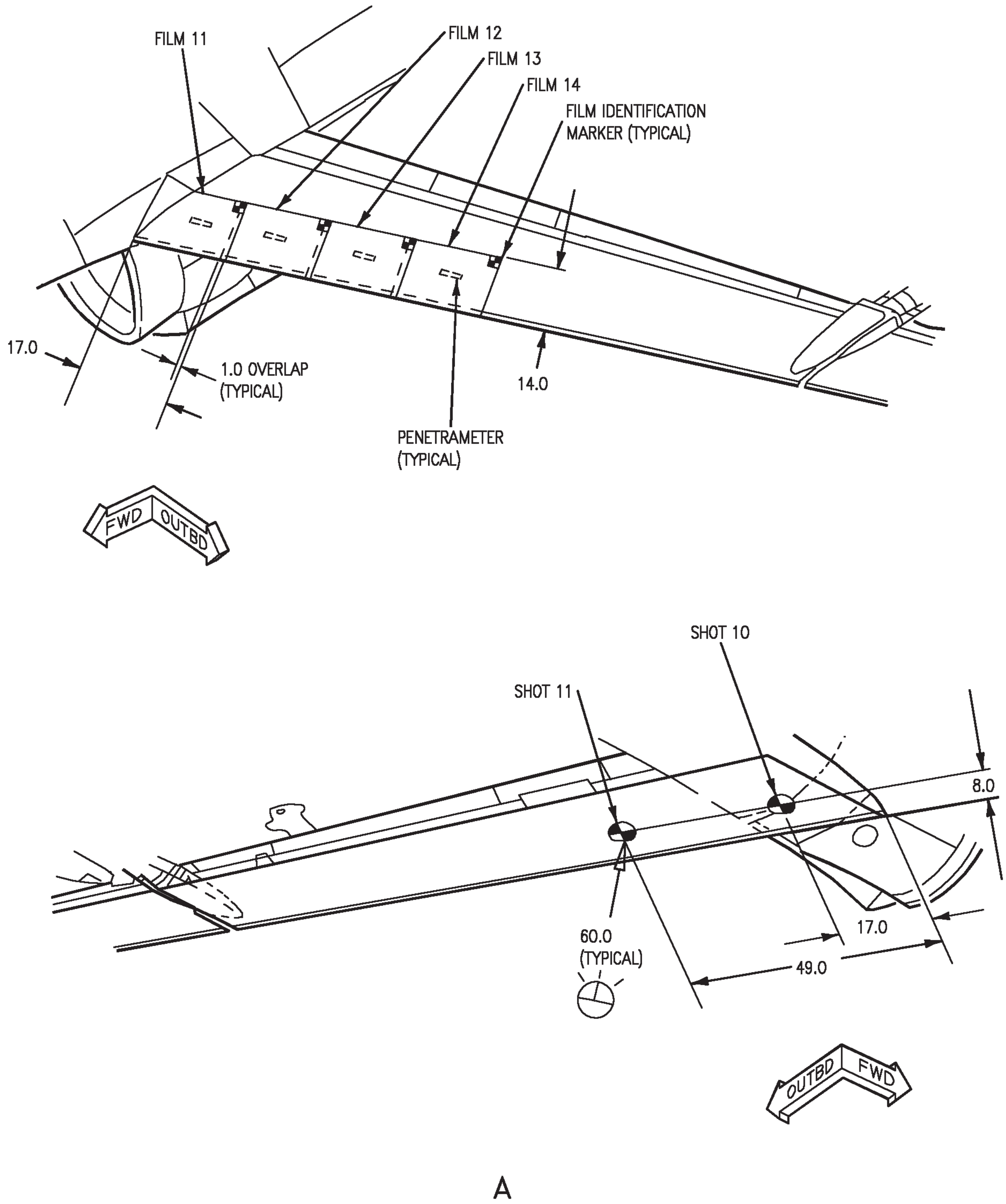
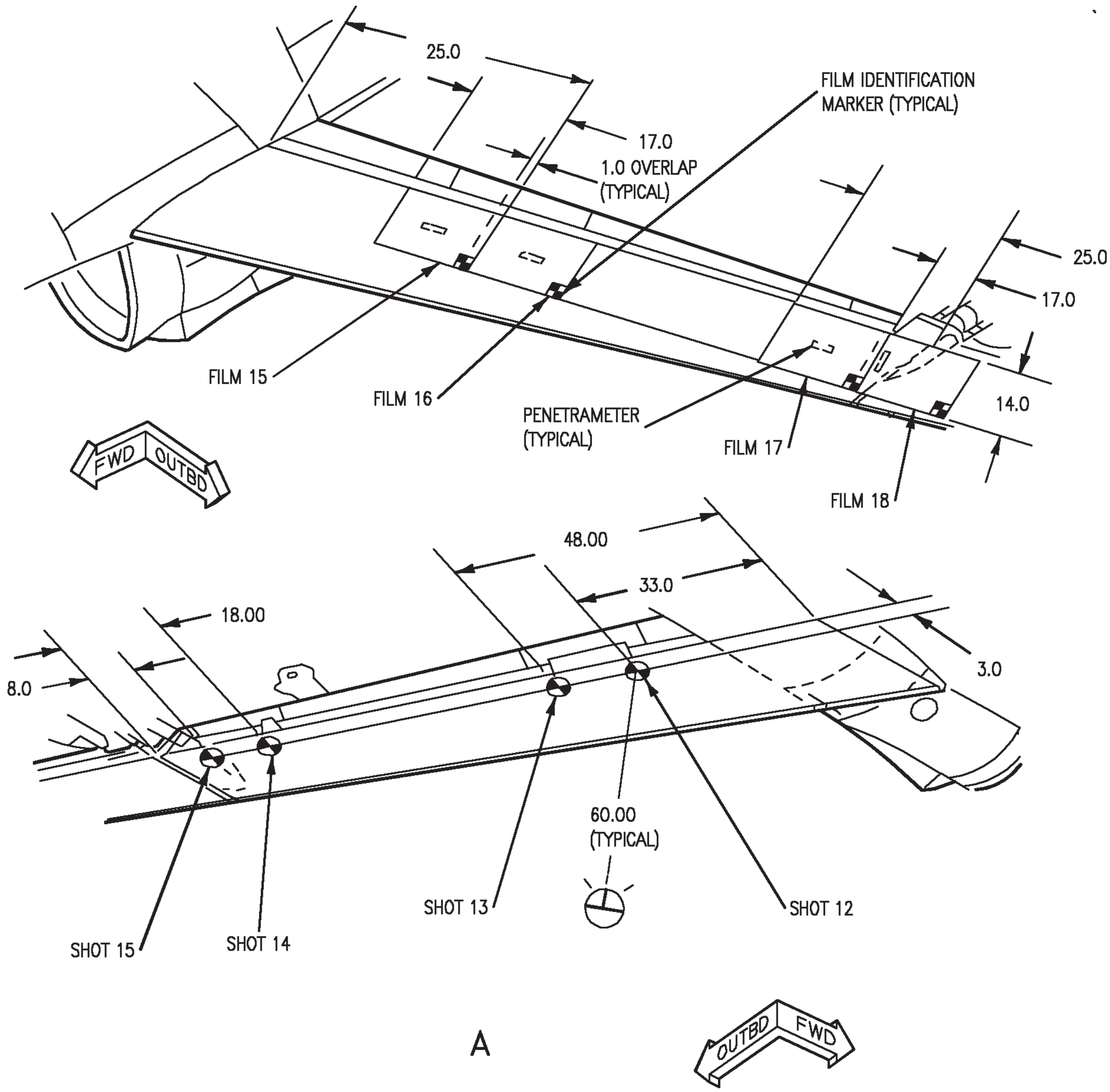


Figure 1. Inboard Flap, Water in Honeycomb (Sheet 1)



18AC-SRM-30-(108-2)34-SCAN

Figure 1. Inboard Flap, Water in Honeycomb (Sheet 2)



LEGEND

1 H AND D DENSITY UNITS

TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1 THRU 7	14 X 17	AA AND M	NO	0.37 AL	3.0	75	2-1 2	1.0-3.5
8 THRU 11	14 X 17	AA AND M	NO	0.25 AL	2.5	70	2	1.0-3.5
12 THRU 13	14 X 17	AA AND M	NO	1.00 AL	3.5	95	4	1.0-3.5
14 AND 15	14 X 17	AA AND M	NO	1.00 AL	3.5	90	2-1 2	1.0-3.5

18AC-SRM-30-(108-3)34-SCAN

Figure 1. Inboard Flap, Water in Honeycomb (Sheet 3)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

ULTRASONIC RESONANCE INSPECTION FOR INBOARD LEADING EDGE FLAP SKIN-TO-SPAR CAP BOND LINE

Reference Material

Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Plane Captain Manual A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INTRODUCTION.**

2. This work package is used to determine condition of adhesive bonds between upper and lower skins and caps of aft spar in inboard leading edge flap. See figure 1.

3. **DEFECTS.** Inspect for skin to aft spar cap unbonds on upper and lower surfaces.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic resonance method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044..

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Make sure inboard leading edge flaps are in full up condition.

Support Equipment Required

NOTE

Alternate type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
1877AS100-1	Stavely Sonic Bondmaster with Accessory Kit
TTU-516E	Accessory Kit
137621	Reference Standard

Support Equipment Required (Continued)

NOTE

Alternate type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
BMR3 (1877AS166-1 RES 3 112 KHz)	Inboard Leading Edge Flap Bondmaster Probe

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
GENERIC	Any cleaning solvent approved for use and acceptable per local environmental regulations.
COMMERCIAL MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Tube Type Marker Aircraft Marking Pencil
CCC-C-46, TYPE I CLASS 4	Cleaning Cloth

WARNING

Cleaning solvent is toxic to eyes, skin, and respiratory tract. Skin/eye protection is required. Avoid repeated/prolonged contact. Use only in well ventilated areas.

8. **Preparation of Part.**

a. Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) are free of contamination or foreign material.

b. Trace outline of aft spar on upper and lower skin as dimensioned in figure 2, and as below;

(1) Make overlay of part to scale and transfer information about shape of substructure on part surface with aircraft marking pencil.

(2) If inspection will not be repeated, mark shape of substructure on surface of upper and lower skin with aircraft marking pencil.

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using electrical equipment near fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

9. **Equipment Settings/Standardization/Setup.** See figure 3.

a. Select RESONANCE mode.

b. Connect BMR3, 110 KHz, or 1877AS166-1 (RES3) probe to connector.

c. Connect connector to Bondmaster, (tester).

d. Press POWER button until indicators illuminate and release. Tester will do its self diagnostic test and display PLEASE WAIT on screen. System will then set up resonant frequency for specific probe.

e. Press ALARM.

f. Press LIMITS.

g. Press HEIGHT and adjust SMART knob until screen displays 35.

h. Press WIDTH and adjust SMART knob until screen displays 100.

i. Press VERT. POS. and adjust SMART knob until screen displays 0.

j. Press HORZ. POS. and adjust SMART knob until screen displays 0. Now screen should have ALARM gate which includes all lower part of screen to vertical height of 35 percent as shown in figure 3.

NOTE

Different standardization procedures are used for different geometry conditions of skin-to-spar cap bond line. Areas labeled on reference standard in figure 4, and on inboard leading edge flap description in figure 2, indicate reference standard and part simularity.

k. Position BMR3 probe on reference standard surface in bonded area. See figure 4 for description of reference standard. See figure 5 for applicable screen traces/dot locations received with probe at various locations on reference standard.

l. Adjust SMART knob until GAIN displays 14 dB.

m. Press NULL.

n. If dot is located at center of screen, at intersection of X and Y lines on screen, after NULL is pressed, go to step p. If not, press SPCL and V-POS and adjust SMART knob until dot is located at center of screen in vertical direction.

o. Press H-POS and adjust SMART knob until NULL point is at center of screen in horizontal direction. Both V-POS and H-POS should read about 50 percent .

p. Press RUN.

q. Press ERASE until message along side of ERASE is; ERASE ALL DOTS.

r. Press NULL.

s. Rock probe to lift probe off reference standard surface. Lift-off trace formed as dot moves away from center should be horizontally to left. If it is, go to step U. If not, adjust lift-off direction by pressing ROTATION and adjusting SMART knob until lift-off trace is generally horizontal and to left.

t. Press NULL to make sure lift-off trace is still to left on screen. For BMR3 probe, ROTATION will be approximately 320 plus or minus 40.

u. Trace for good bond will be displayed in part of screen titled Good Bond Area, see figure 5, A. Trace for unbond will appear in part of screen titled Unbond Area, see figure 5, B.

v. Tester should be ready for inspection.

10. **Inspection Procedure.**

NOTE

Use reference standard to establish normal lift-off direction. Stay within area of part which best represents specific part of reference standard where lift-off in horizontal direction was established. Restandardize by establishing horizontal lift-off on applicable part of reference standard before inspecting part of upper or lower surface of inspection area(s) with different geometry.

a. Position probe on surface of reference standard which simulates area of skin to be inspected.

b. Press NULL.

c. When probe is coupled to slotted area of reference standard, trace located in Unbond Area of screen should be result. When probe is coupled to non-slotted area of reference standard, trace located in Good Bond Area of screen should be result. Trace formed by positioning, lifting, probe off or on reference standard should be generally horizontal. Screen displays like those shown in figure 5, A and B should be displayed. If not, press ROTATION and adjust SMART knob until lift-off trace is horizontally to left, from bonded area.

d. Position probe on part. Lift-off direction should be same, if area of part and reference standard are similar.

NOTE

During typical inspection of metal-to-metal bond, dot should float around NULL point and stay within area 1. This dot movement is likely due to difference in skin or spar cap thickness and film adhesive bond thickness.

e. Tester is adjusted so lift-off trace is horizontal to left. In similar area of reference standard, which is bonded, unbond will display trace which is downward, into area 2 and will cause ALARM light to illuminate as probe moves into vicinity of unbond.

f. Always make sure there is enough couplant beneath probe when inspecting. Probe may be

moved across surface, but best results are received when probe is positioned on surface.

g. Inspect all areas of inspection area(s), with same thickness, by scanning in inboard-to-outboard direction and indexing approximately 1/2 of probe dia. in forward / aft direction. As probe enters area with slightly different skin thickness, and moves forward / aft, or moves into area with different skin / substructure geometry, dot may tend to drift about within area 1. If dot drifts into area 2, position probe on surface of reference standard similar to area of skin in question, and press NULL.

h. Press ROTATION and adjust SMART knob, if required, to get lift-off trace in horizontal direction.

i. Position probe on part surface in suspect area, and determine if ALARM is triggered as probe slides / is positioned over area of unbond. If ALARM triggers, area is unbonded. If not, initial ALARM light should be disregarded.

j. Inspect 100 percent of upper and lower surface skin-to-spar cap bonded areas.

k. Scan parallel to leading or trailing edge of substructure.

l. If unbond is detected, map its shape. Move probe in generally inboard or outboard direction. Mark, with aircraft marking pencil, on surface, at center of probe, when dot moves into area 2, and triggers ALARM.

m. Report all areas where ALARM is triggered and reevaluation of response and coupling does not make acceptable explanation for response.

WARNING

Cleaning solvent is toxic to eyes, skin, and respiratory tract. Skin/eye protection is required. Avoid repeated/prolonged contact. Use only in well ventilated areas.

11. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

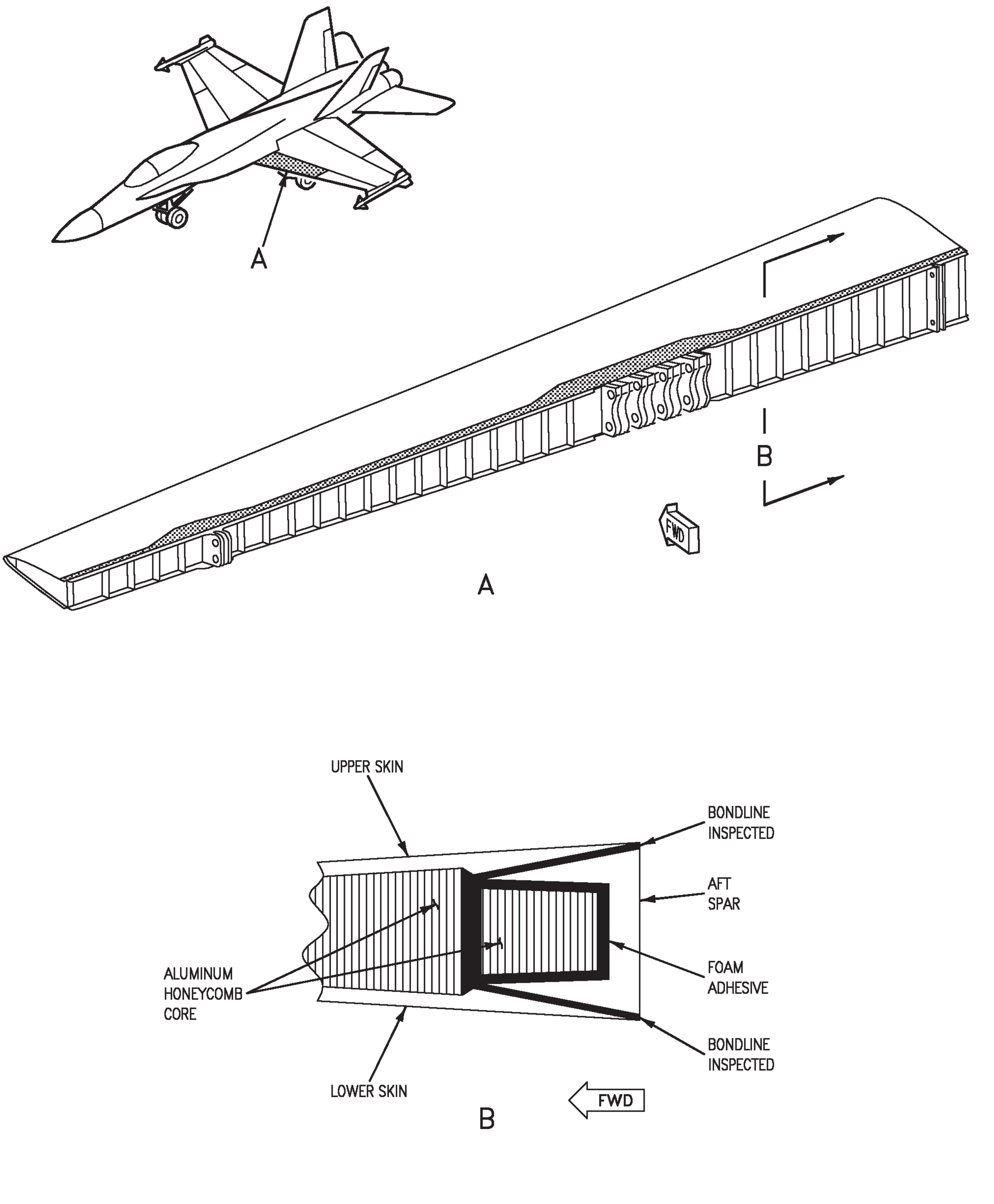


Figure 1. Inspection Areas

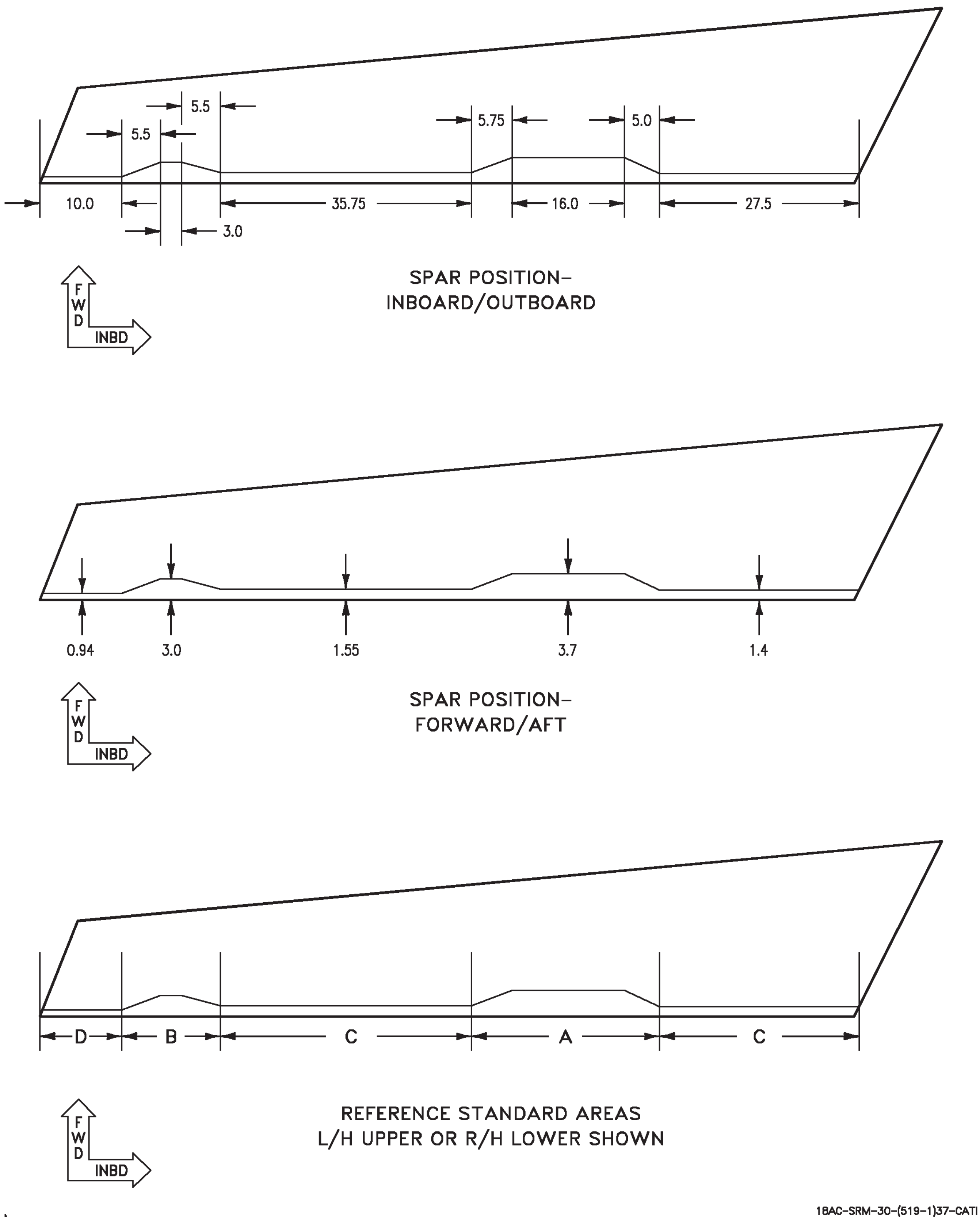
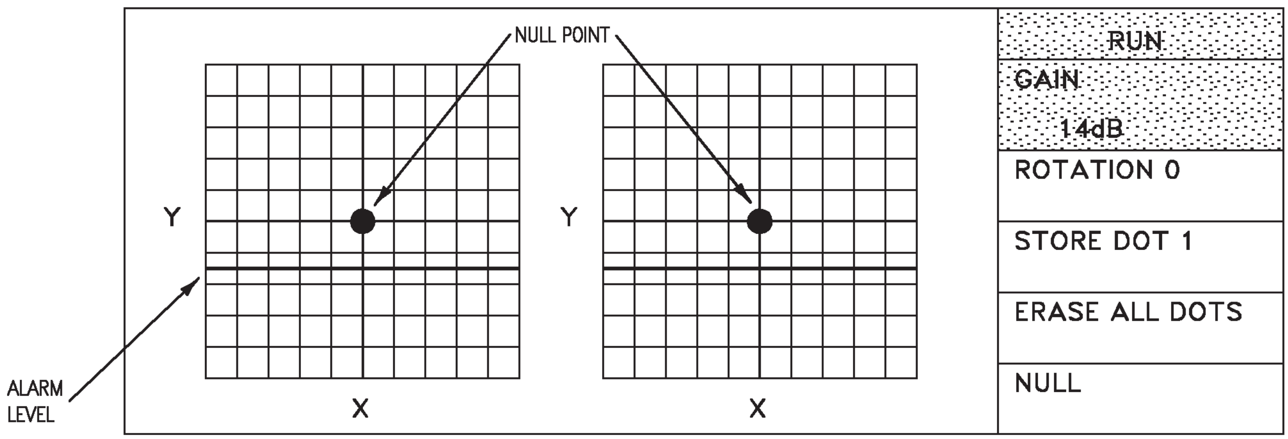


Figure 2. Inboard Leading Edge Flap Description



ALARM SETTINGS:

HEIGHT	35
WIDTH	100
VERT POS	0
HORZ POS	0

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Figure 3. Bondmaster Setup

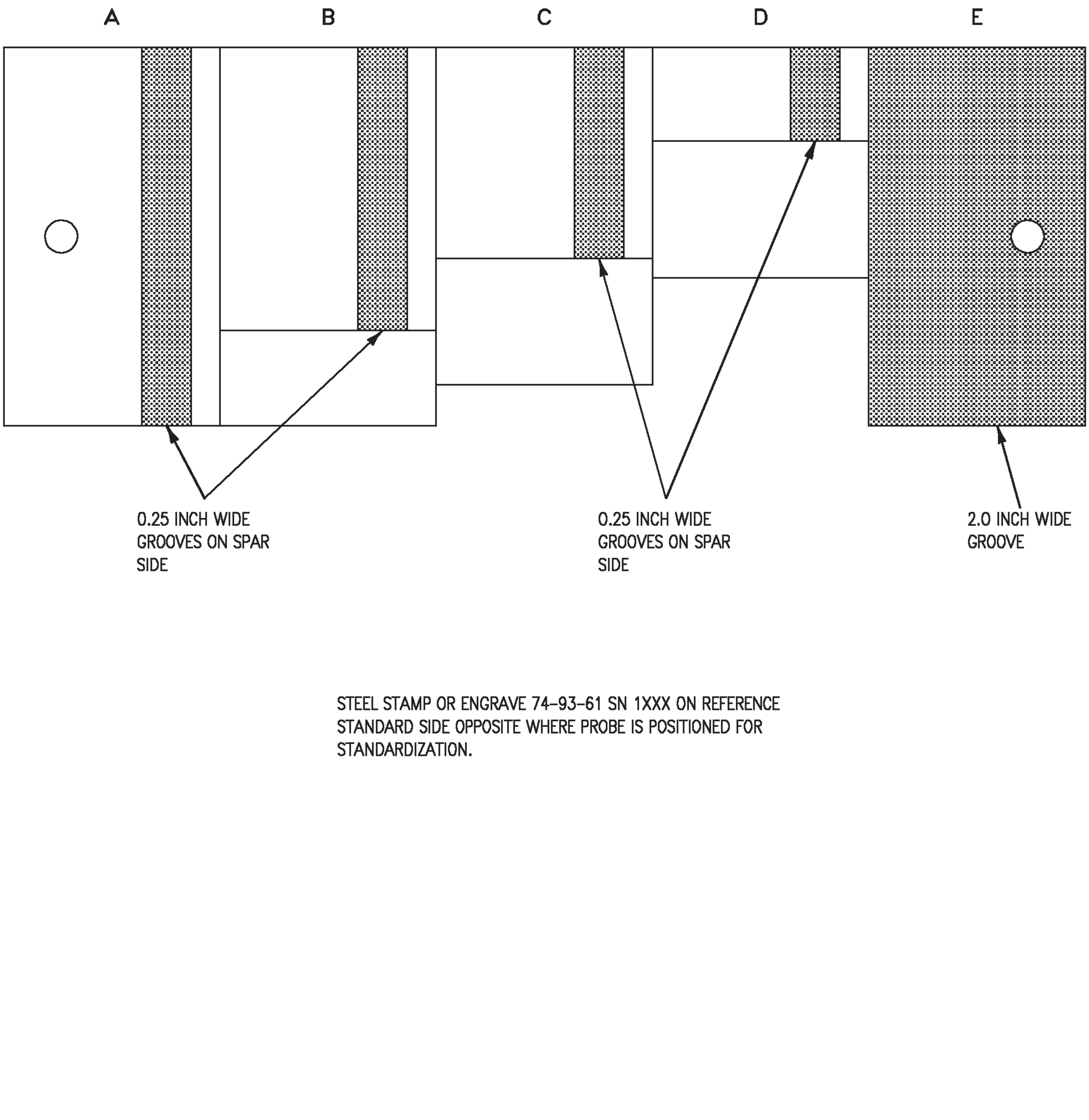
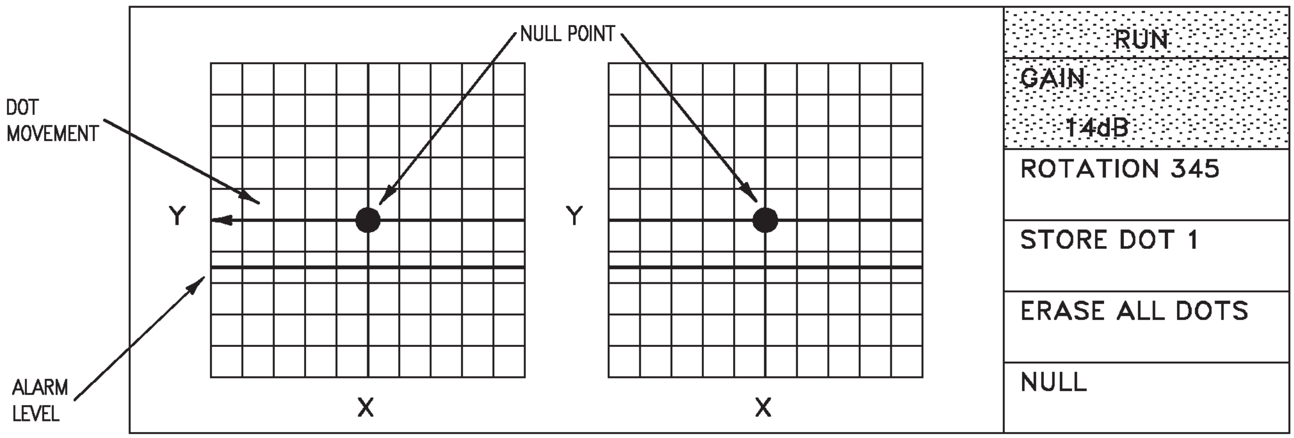
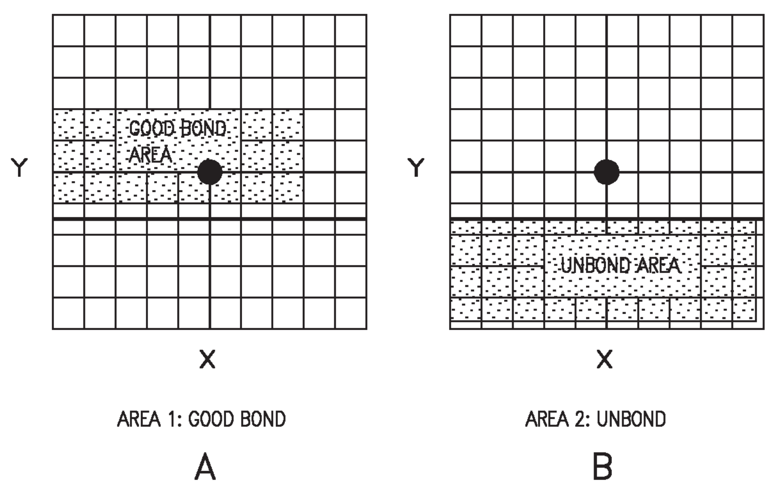


Figure 4. Reference Standard



ROTATION IS ADJUSTED USING SMART KNOB, UNTIL LIFT-OFF TRACE IS HORIZONTAL TO LEFT AS SHOWN, WHEN PROBE IS LIFTED OFF BONDED PART OF REFERENCE STANDARD OR PART.



DOT WILL MOVE INTO AREA 1 IF PROBE IS MOVED WITHIN OR LIFTED OFF BONDED AREA. DOT WILL MOVE INTO AREA 2 IF PROBE IS MOVED FROM GOOD BOND INTO UNBONDED AREA. PHASE/ROTATION OF TRACE IS FUNCTION OF BONDLINE DEPTH BELOW PROBE. UNBONDS STILL SHOULD MAKE A TRACE WITHIN AREA LABELED UNBOND AREA.

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Figure 5. Inspection

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

OUTBOARD FLAP

WATER IN HONEYCOMB

PART NO. 74A190202

Reference Material

Nondestructive Inspection Methods	NAVAIR 01-1A-16
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Radiography	WP005 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. OUTBOARD FLAP.

2. The outboard flap is a bonded honeycomb assembly. Honeycomb core is 0.125 and 0.188 hexagonal cell, 5056 aluminum alloy. Skin and structure enclosing the honeycomb core is 7075 and 7175 aluminum alloy. Surface finish is epoxy primer and polyurethane coating.

3. **DEFECTS.** Inspect for water trapped in honeycomb core. Example of defect is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is radiographic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-STD-453	Penetrameter Set
GXR7-6B	X-ray Apparatus, Portable
072000	X-ray Film Processor
314X	Film Identification Set

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
INDUSTREX M FILM CODE M2 or INDUSTREXM FILMCODEM2 5X7 or INDUSTREXAAFILM CODE 14X17	Radiographic Film, X-ray Film 5 x 7 and 14 x 17
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **Preparation of Part.** No special preparation required.

WARNING

HIGH RADIATION

Make sure applicable safety precautions in (WP005 00 and NAVAIR 01-1A-16) are complied with. Failure to comply may result in injury to personnel.

9. **Equipment Settings/Standardization/Setup.** Set X-ray unit per data contained in technique chart, see figure 1.

10. **Inspection Procedure.**

NOTE

X-ray film for shots are double loaded. AA film is located next to the part and both films are exposed simultaneously.

a. Locate films 1 through 4 for shots 1 through 4. Film should be taped to upper surface of outboard flap with identification markers taped to source side of film pack and penetrameters taped to source side of outboard flap.

b. Locate source to aiming point for shots 1 through 4. Source should be normal to aiming point.

c. Expose films 1 through 4 using technique chart settings for shots 1 through 4. Remove exposed film.

d. Repeat steps a through c for films 5 and 6 and shot 5.

e. Repeat steps a through c for films 7 and 8 and shot 6.

f. Process exposed film. Interpret radiographs for water trapped in honeycomb core (WP005 00).

g. Mark defect(s) using an aircraft marking pencil.

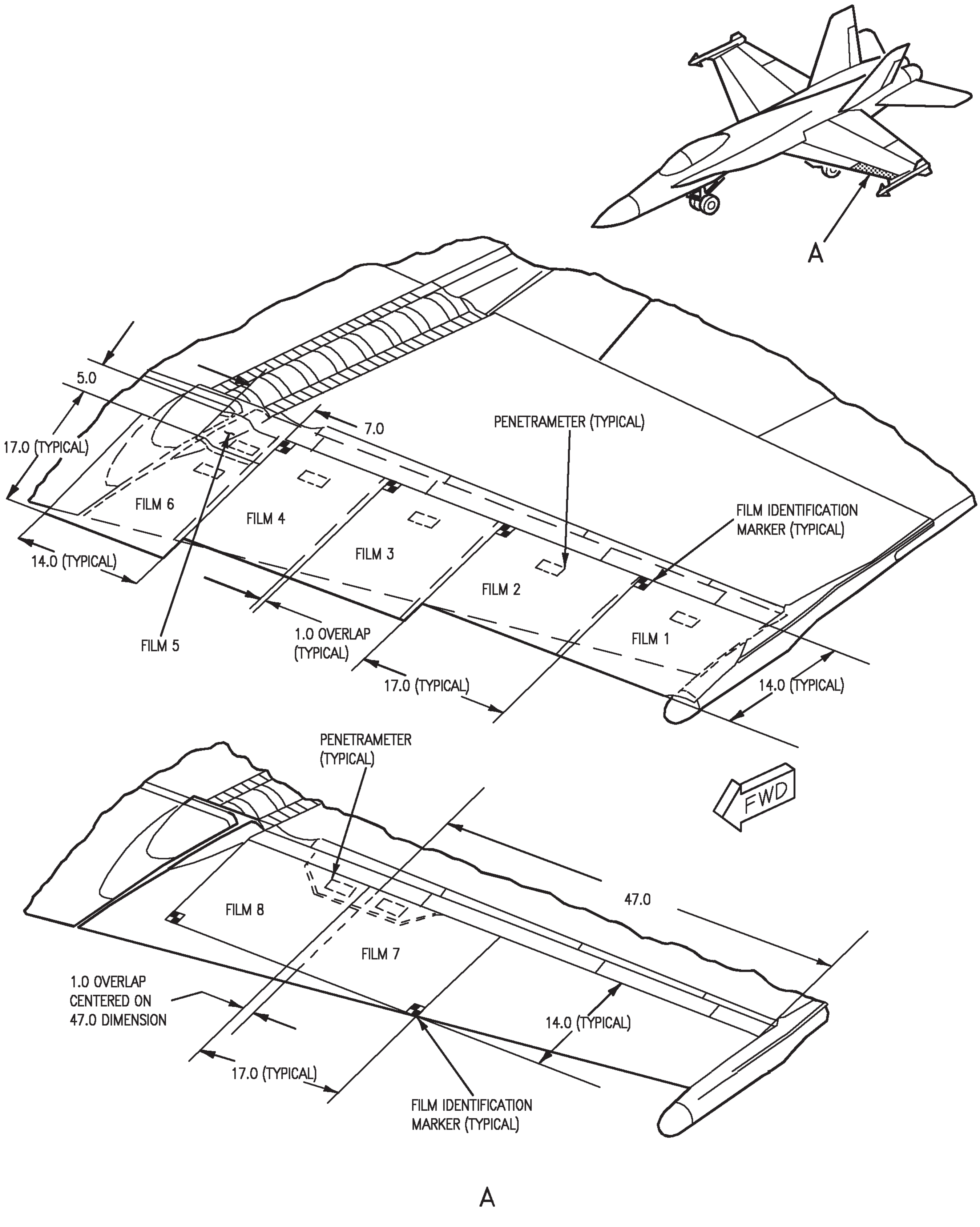
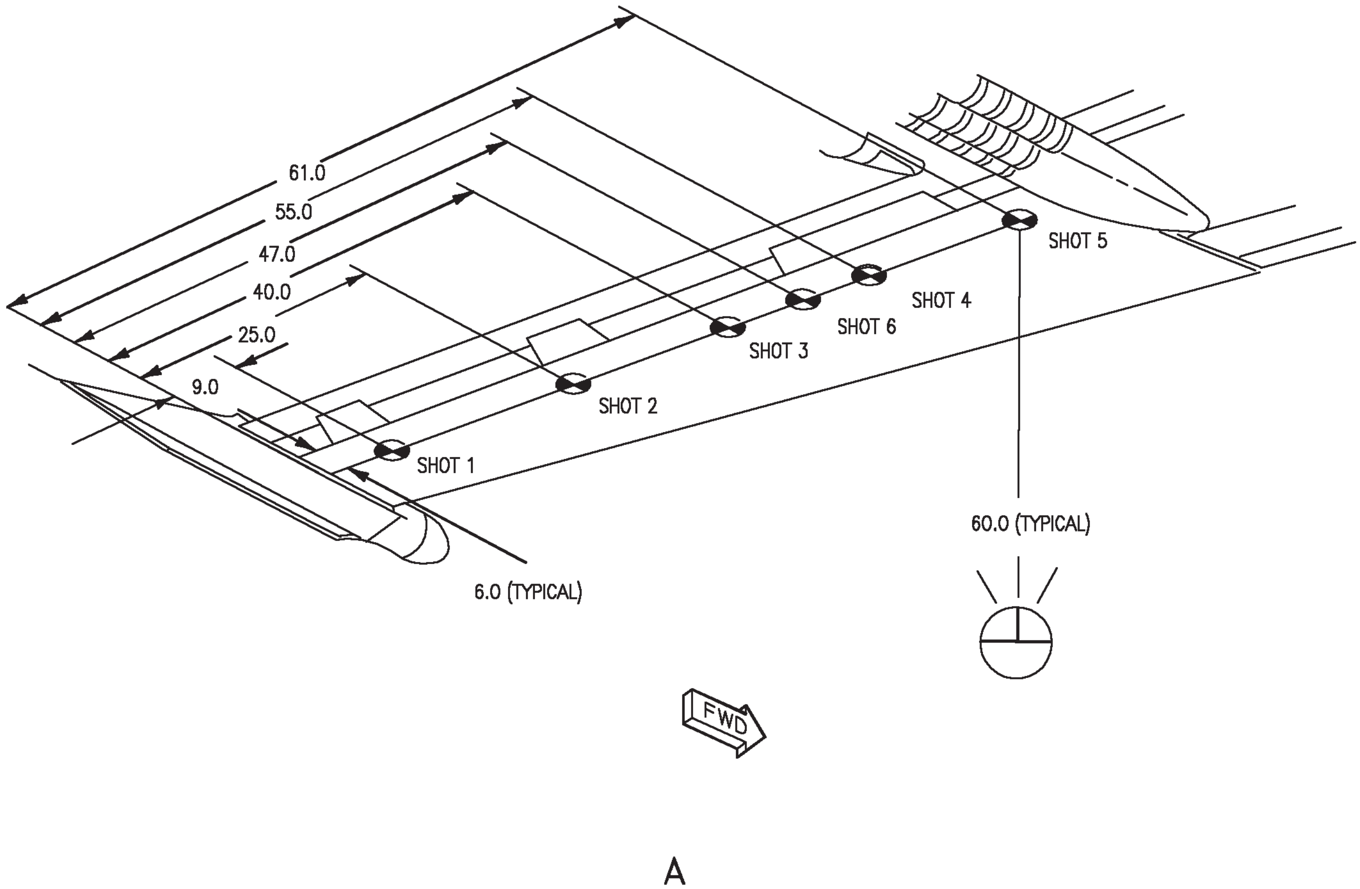


Figure 1. Outboard Flap, Water in Honeycomb (Sheet 1)



LEGEND

1 H AND D DENSITY UNITS

TECHNIQUE CHART								
SHOT	FILM SIZE	FILM GROUP	SCREEN	PENETRAMETER MIL-STD-453	mA	kVP	EXPOSURE (MINUTES)	1 DENSITY
1 THRU 4	14 X 17	AA AND M	NO	0.25 AL	2.5	75	2-1/2	1.0-3.0
5	14 X 17 AND 5 X 7	AA AND M	NO	0.25 AL	2.5	75	2-1/2	1.0-3.0
6	14 X 17	AA AND M	NO	1.00 AL	3.5	90	3-1/2	1.0-3.0

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Figure 1. Outboard Flap, Water in Honeycomb (Sheet 2)

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

INNER WING LOWER SKIN ATTACH HOLES

FATIGUE CRACKS

PART NO. 74A110603

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Aircraft Weapons Systems Cleaning and Corrosion Control	NAVAIR 01-1A-509
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Inner Wing Skins and Attach Pins	WP003 00
Structure Repair, Wing	A1-F18AE-SRM-600
Inner Wing Removal and Installation	WP047 00
Inner Wing Skins and Attach Pins	WP003 00
Nondestructive Inspection	A1-F18AC-SRM-300
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Finish System	WP012 00
Stripping	WP007 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **INNER WING LOWER SKIN ATTACH HOLES.**

2. Inner wing lower skin attach holes (attach holes), located in inboard root splice area, see figure 1, are subjected to shear loads. Attach holes are drilled into forged and machined 6AL-4V titanium alloy. Surface finish surrounding attach holes is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect attach holes and surrounding surfaces for fatigue cracks.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is fluorescent penetrant.

5. **Personnel Qualifications.** Personnel doing this inspection should be qualified and certified to do radiographic inspections per OPNAVINST 4790.2 SERIES.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (XMA101) (TT10)	Portable Fluorescent Penetrant Inspection Kit
M-16	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl Isobutyl ketone, are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.**

a. Have bushings removed (A1-F18AC-SRM-210, WP003 00 or A1-F18AE-SRM-600, WP003 00).

b. Have paint removed from inspection areas (A1-F18AC-SRM-500, WP007 00).

c. Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

9. **Inspection Procedure.** Do type I, method C fluorescent penetrant inspection (A1-F18AC-SRM-300, WP004 00 and NAVAIR 01-1A-16).

a. After removing excess penetrant, spray thin film of developer on inspection surface.

b. View inspection area for cracks.

c. Mark defects with aircraft marking pencil.

10. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection material from part with a solvent moistened cloth.

b. Refinish good part (A1-F18AC-SRM-500, WP012 00 and NAVAIR 01-1A-509).

11. **SYSTEM SECURING.**

a. Have bushings reinstalled (A1-F18AC-SRM-210, WP003 00 or (A1-F18AE-SRM-600, WP003 00).

b. Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00 or (A1-F18AE-SRM-600, WP047 00).

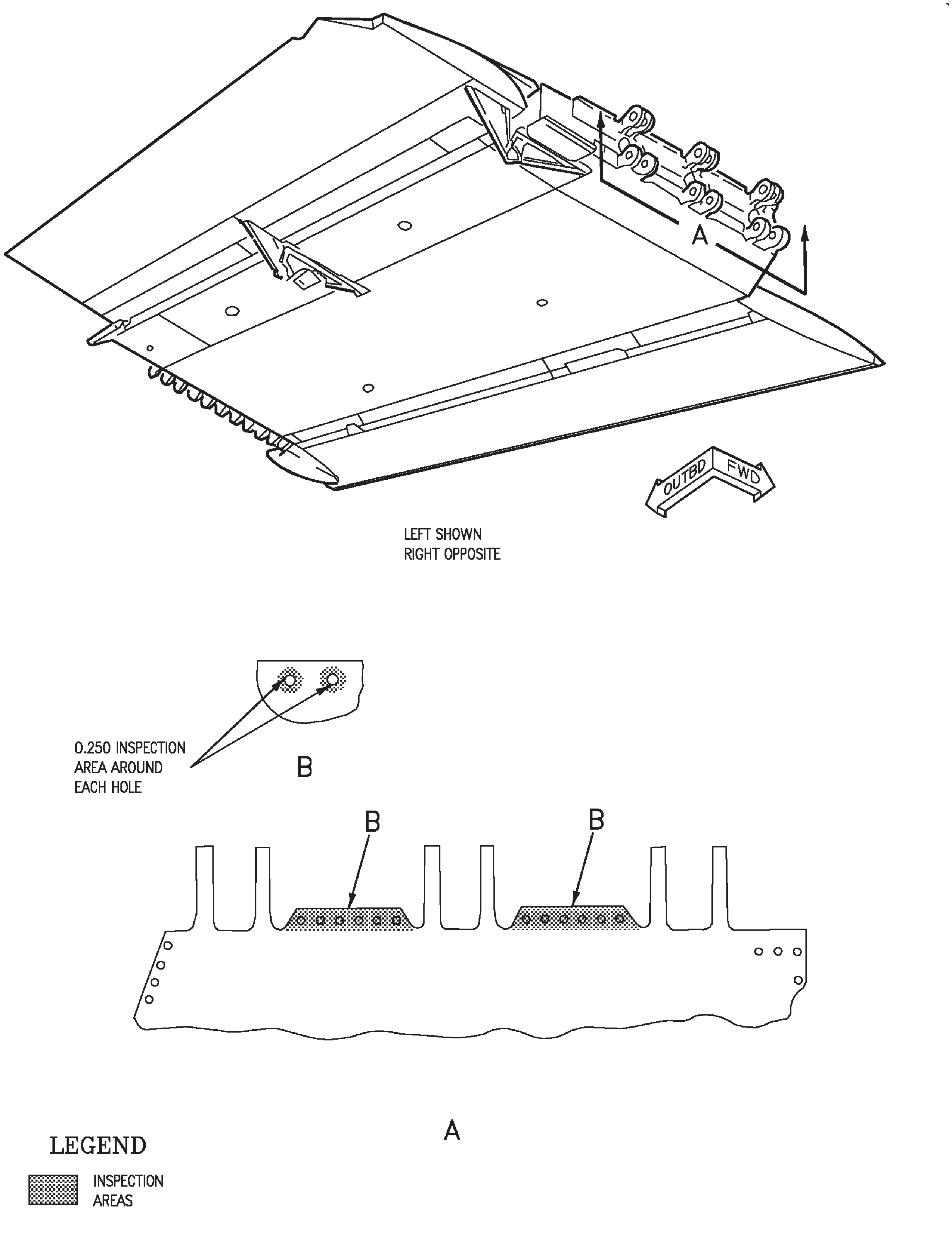


Figure 1. Inner Wing Lower Skin Attach Holes

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

INNER WING TO FUSELAGE, UPPER AND LOWER ATTACH PIN ASSEMBLIES

FATIGUE CRACKS

PART NO. 74A110680

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Inner Wing Skins and Attach Pins	WP003 00
Structure Repair, Wing	A1-F18AE-SRM-600
Inner Wing Removal and Installation	WP047 00
Inner Wing Skins and Attach Points	WP003 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Nondestructive Inspection	A1-F18AC-SRM-300
Magnetic Particle Method	WP006 00
Penetrant Method	WP004 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. INNER WING TO FUSELAGE ATTACH PIN ASSEMBLIES.

2. Wing to fuselage attach pin assemblies (attach pin assemblies) are machined PH13-8 stainless steel hollow cylinders. Upper attach pin assemblies contain cold shrunk 7075 aluminum inserts.

3. **DEFECTS.** Inspect surface of attach pin assemblies for fatigue cracks, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary Inspection method is magnetic particle method.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and

certified to do magnetic particle inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing attach pin assemblies removed (A1-F18AC-SRM-210, WP003 00 and WP025 00 or A1-F18AE-SRM-600, WP003 00 and 047 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
H-710G	Stationary Magnetic Particle Inspection Unit
2480	Magnetic Particle Field Indicator
M-16 (ZB-26)	Black Light, Portable,
—	14X Pocket Magnifier
J-221	Ultraviolet Meter

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
14AM or AMS3044	Fluorescent Magnetic Inspection Compound, Prepared Bath, Spray Can
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, Class A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl Isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean attach pin assemblies with solvent moistened cloth to make sure inspection area is free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** Do Equipment Settings/Standardization/Setup For Circular Magnetization Using Stationary Equipment (WP006 00) and Equipment Settings/Standardization/Setup For True Continuous Longitudinal Magnetization Using Probe (WP006 00) and as below:

a. Do central conductor magnetization setup on lower attach pin assemblies using figure 2, table 1.

b. Do central conductor magnetization setup on lower attach pin assemblies using figure 3, table 1.

c. Do probe magnetization setup on upper and lower attach pin assemblies using figure 4, table 1.

10. **Inspection Procedure.** Do Inspection Procedure For Circular Magnetization Using Stationary Equipment (WP006 00), Inspection Procedure For True Continuous Longitudinal Magnetization Using Probe (WP006 00), and as below:

a. Do central conductor inspection on upper and lower attach pin assemblies, see figures 2 and 3.

b. Do probe inspection on upper and lower attach pin assemblies, see figure 4.

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant method. Fluorescent penetrant may be used to verify indications detected by primary inspection method.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

13. **Preparation of Aircraft.** No special preparation required.

14. **Access.** Have inner wing attach pin assemblies removed (A1-F18AC-SRM-210, WP003 00 and WP025 00) or (A1-F18AE-SRM-600, WP003 00 and 047 00).

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (XMA101) (TT10)	Fluorescent Penetrant Inspection Kit, Portable
M-16 (ZB-26)	Black Light
—	5 to14X Magnifier

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl Isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

15. **Preparation of Part.** Clean attach pin assemblies with solvent moistened cloth to make sure inspection area is free of contamination or foreign material.

16. **Inspection Procedure.** Do type I, method C fluorescent penetrant inspection (WP004 00 and NAVAIR 01-1A-16).

a. After removing excess penetrant, spray thin film of developer on inspection area.

b. Use black light and 5 to 14X magnifier to view surface for cracks.

c. Mark defects, as required, with an aircraft marking pencil.

WARNING

17. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection material from inspection area with solvent moistened cloth.

18. **SYSTEM SECURING.** Have inner wing attach pin assemblies reinstalled (A1-F18AC-SRM-210, WP003 00 and WP025 00) or (A1-F18AE-SRM-600, WP003 00 and WP047 00).

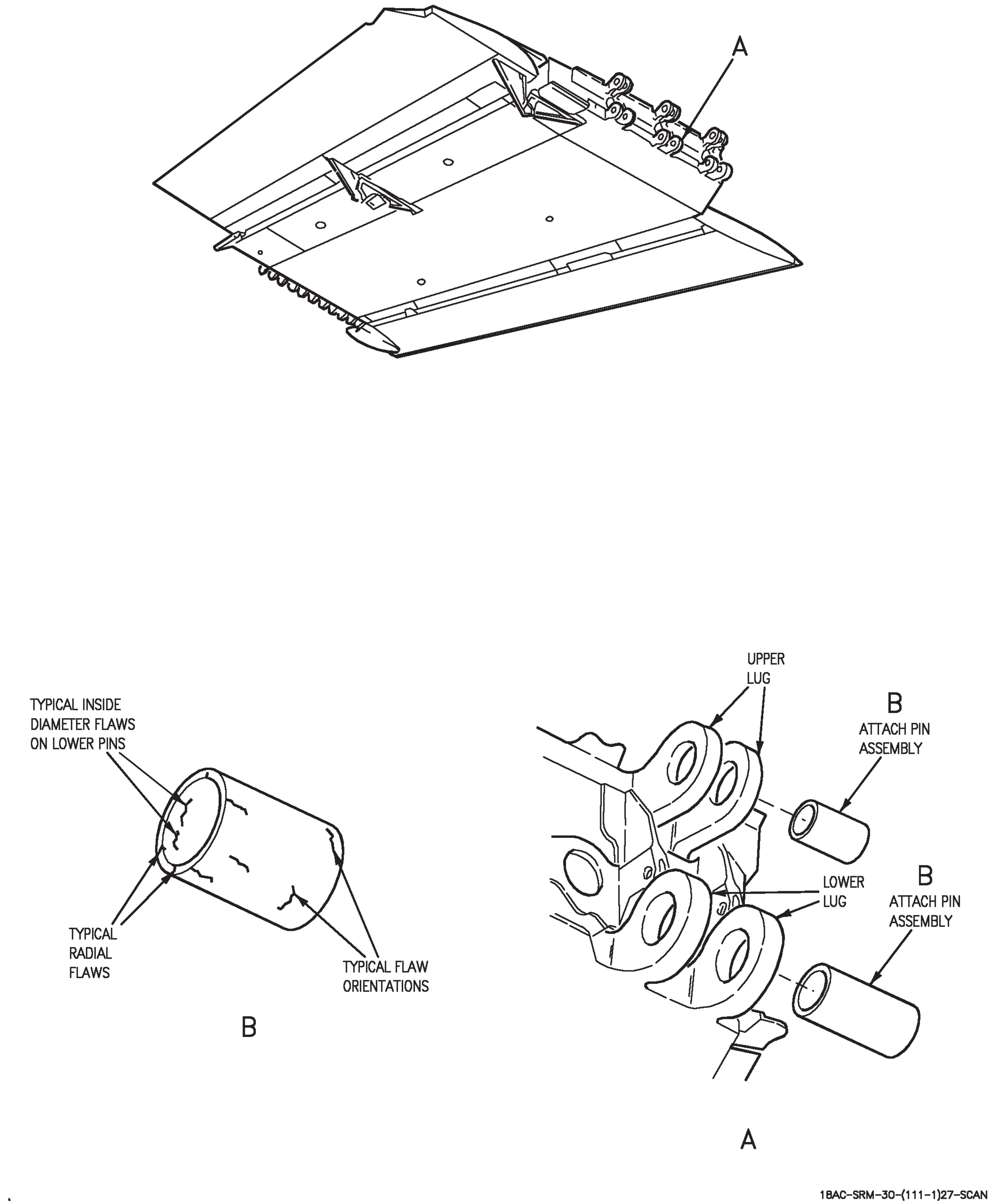


Figure 1. Attach Pin Assembly Location and Flaw Orientation

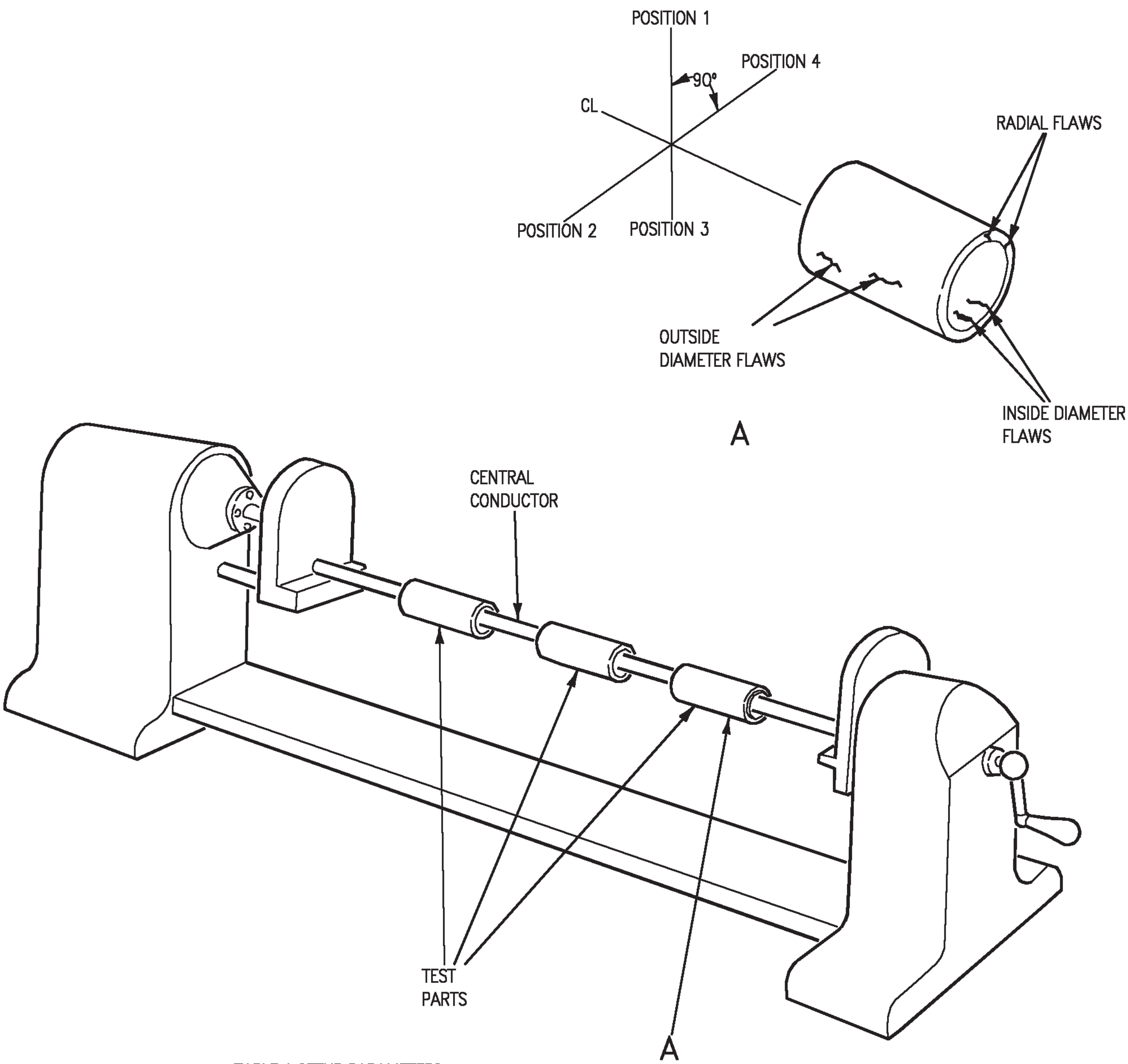


TABLE 1 SETUP PARAMETERS

MAGNETIZATION METHOD	CIRCULAR CENTRAL CONDUCTOR
INSPECTION METHOD	WET CONTINUOUS
CENTRAL CONDUCTOR SIZE	0.500 INCH DIA
POLARITY	DC
CURRENT	1250
SHOT LENGTH	0.500 SECOND
SHOTS PER POSITION	3
SHOT POSITIONS	4
PART ORIENTATION	ROTATE PIN 90° FOR EACH SHOT POSITION

18AC-SRM-30-(112-1)27-SCAN

Figure 2. Central Conductor Setup and Flaw Locations for Lower Attach Pins

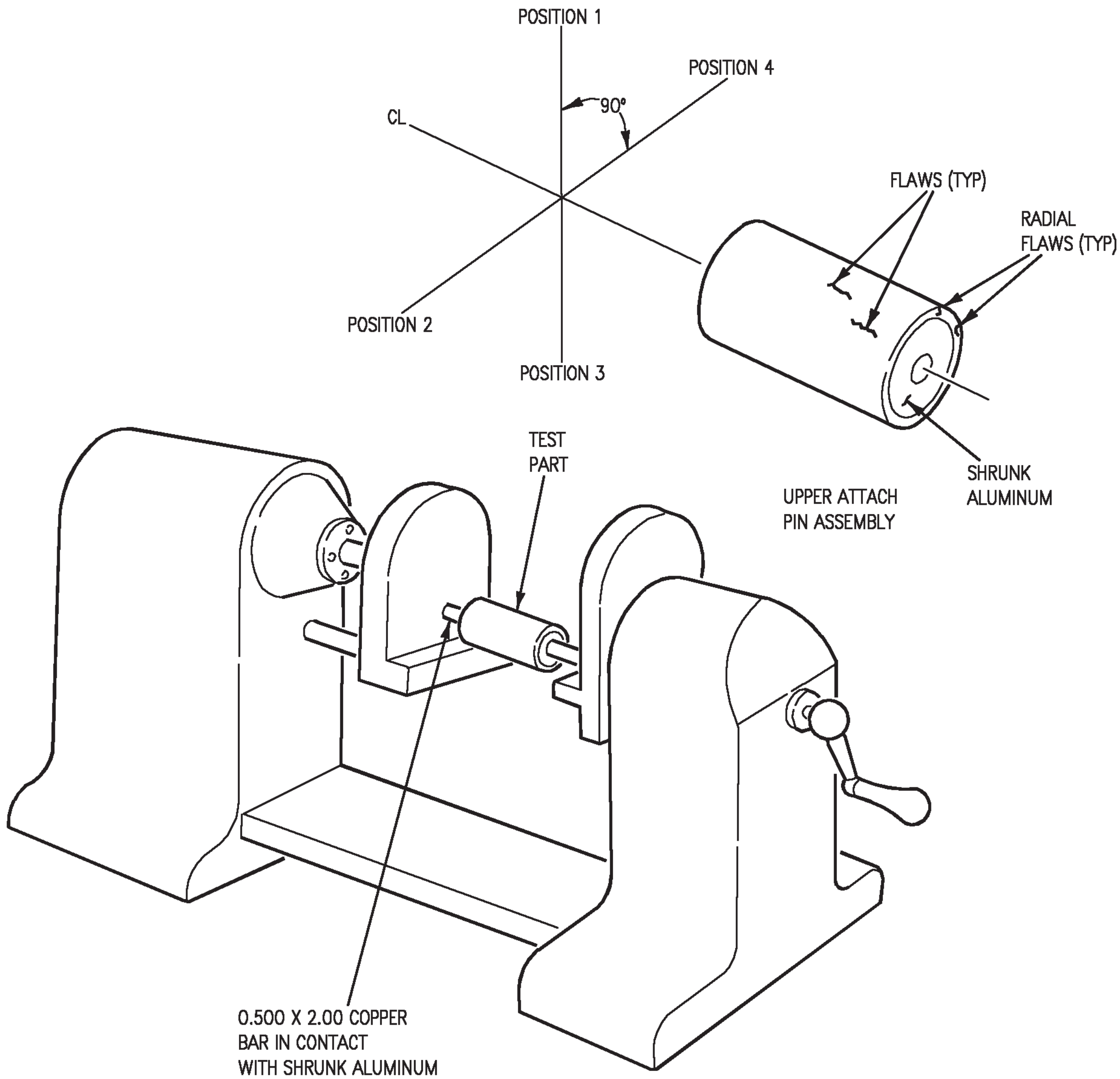


TABLE 1 SETUP PARAMETERS

MAGNETIZATION METHOD	CIRCULAR CENTRAL CONDUCTOR
INSPECTION METHOD	WET CONTINUOUS
CENTRAL CONDUCTOR SIZE	0.500 INCH DIA
POLARITY	DC
CURRENT	1250
SHOT LENGTH	0.500 SECOND
SHOTS PER POSITION	3
SHOT POSITIONS	4
PART ORIENTATION	ROTATE PIN 90° FOR EACH SHOT POSITION

18AC-SRM-30-(113-1)27-SCAN

Figure 3. Central Conductor Setup and Flaw Locations for Upper Attach Pins Assemblies

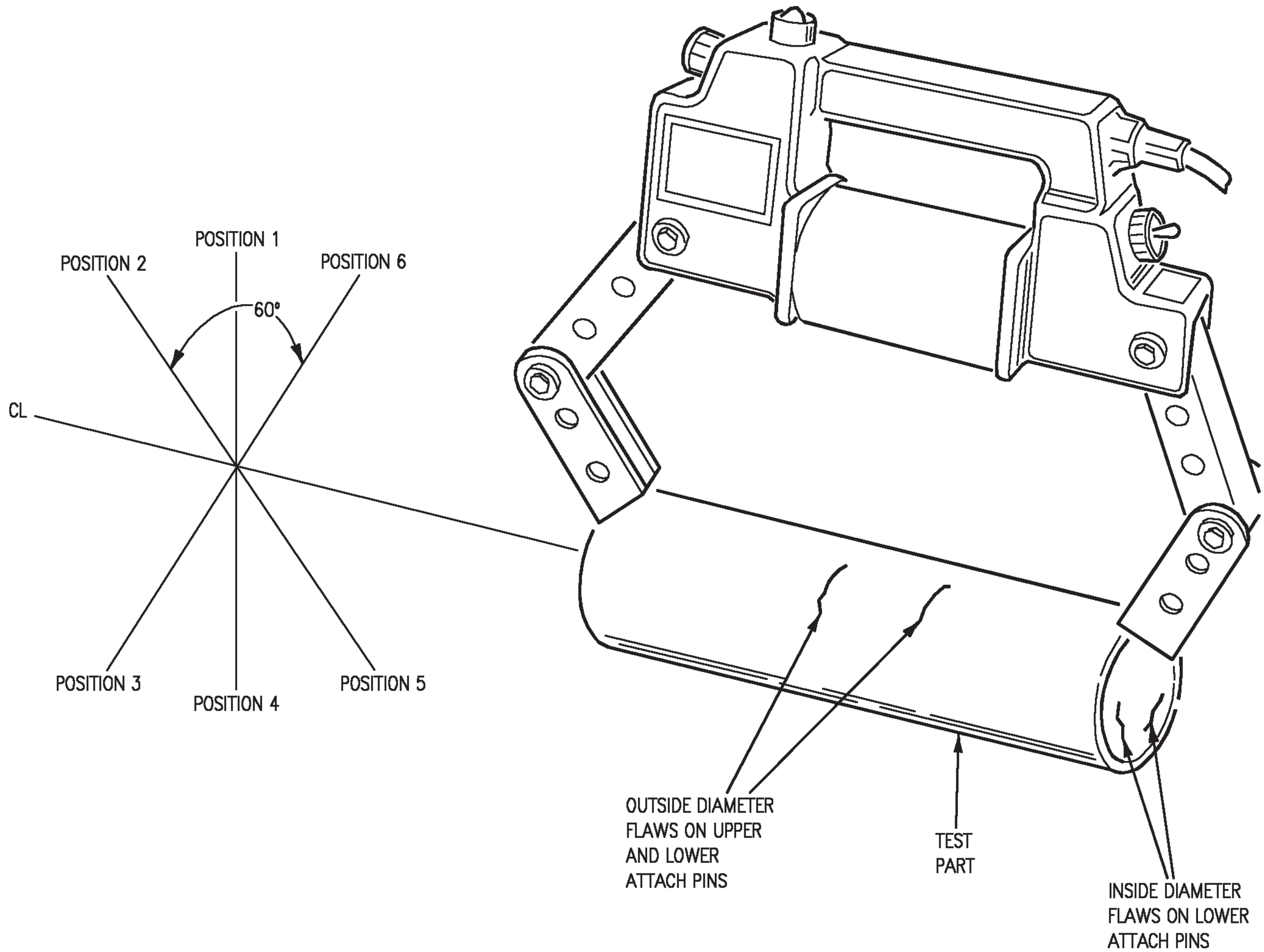


TABLE 1 SETUP PARAMETERS

MAGNETIZATION METHOD	LONGITUDINAL YOKE
INSPECTION METHOD	WET CONTINUOUS
POLARITY	DC
CURRENT	MAX
SHOT LENGTH	15-60 SECONDS
SHOTS PER POSITION	2-3
SHOT POSITIONS	6
PART ORIENTATION	ROTATE PIN 60° FOR EACH SHOT POSITION

18AC-SRM-30-(114-1)27-SCAN

Figure 4. Probe Setup and Flaw Locations for Upper and Lower Attachment Pin Assemblies

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

INNER WING DRAG LOAD MEMBER, FUSELAGE TO WING ATTACH HOLES

FATIGUE CRACKS

PART NO. 74A110632

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Hole Inspection of Aluminum Alloys	WP007 01
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16

Alphabetical Index

Record of Applicable Technical Directives

None

1. INNER WING DRAG LOAD MEMBER, FUSELAGE TO WING ATTACH HOLES. See figure 1.

2. Inner wing drag load member, fuselage to wing attach holes (attach holes) are located in drag load member; they are subjected to shear loads. Attach holes are drilled in machined and tempered 6061 aluminum alloy. Finish system surrounding attach holes is anodized coating and epoxy primer.

3. **DEFECTS.** Inspect attach holes for fatigue cracks.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector
64109	Bolt Hole Probe, 3/8-Inch Diameter
64113	Bolt Hole Probe, 7/16-Inch Diameter
FG1	Flaw Gate, GK Engineering, Corp.
VM89A	EDM Notch, Hole Reference Standard, Aluminum, VM Products or Equivalent

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-C-87962, TYPE 1	Cleaning Cloth
MIL-P-83953-2 , TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil

WARNING

Dry cleaning solvent and methyl Isobutyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** Do ED520 Flaw Detector Setup (WP007 01) and as below:

a. Setup using 3/8-diameter bolt hole probe for inspection of holes in area 1, see figure 1.

b. Setup using 7/16-diameter bolt hole probe for inspection of holes in area 2, see figure 1.

10. **Inspection Procedure.** Do Inspection Procedure and Flaw Gate Operation With ED520 Flaw Detector (WP007 01) and as below:

a. Inspect area 1 after doing setup with 3/8-diameter bolt hole probe.

b. Inspect area 2 after doing setup with 7/16-diameter bolt hole probe.

c. Sharp down scale meter deflection exceeding 100 milliamperes is indication of fatigue cracks.

d. Mark defects with aircraft marking pencil and record.

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Fluorescent penetrant may be used to verify indications detected by primary method.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
M-16	Black Light

Materials Required

NOTE

Alternate item specification or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
AA1048TY1CL1 GRIT400X9X11	Aluminum Oxide Abrasive Cloth
MIL-C-85054, TYPE 1	Corrosion Prevention Compound
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
A-A-883	Pressure Sensitive Tape, Masking Tape

13. **Preparation of Aircraft.** Same as primary method.

14. **Access.** Same as primary method.

15. **Preparation of Part.**

a. Have finish system removed from inspection area(s) (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry Cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) are free of contamination or foreign material.

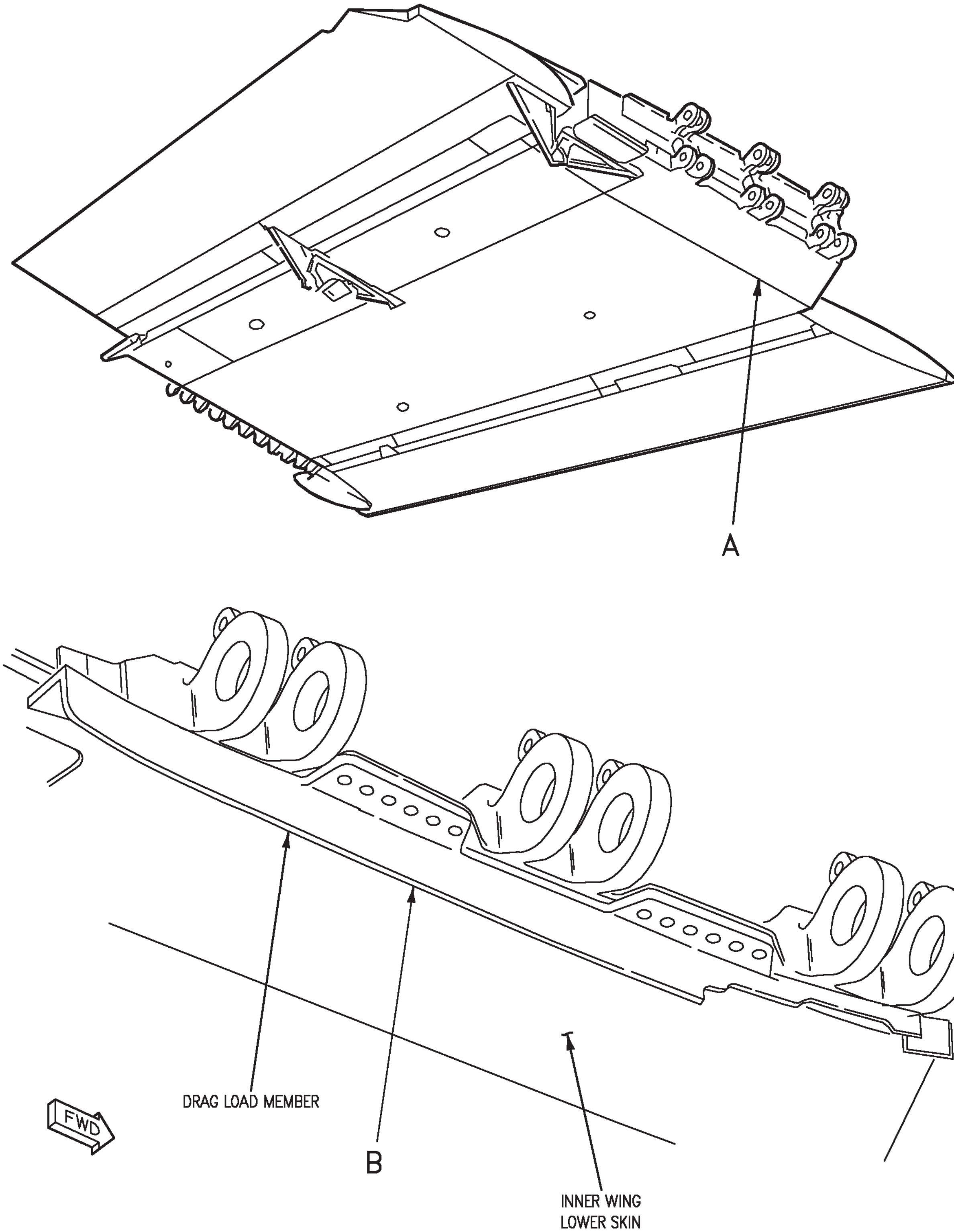
16. **Inspection Procedure.** Do type I, method C fluorescent penetrant inspection (WP004 00 and NAVAIR 01-1A-16).

a. After removing excess penetrant, spray a thin film of developer on inspection surface.

b. View inspection area for cracks.

c. Mark defects with aircraft marking pencil and record.

17. **SYSTEM SECURING.** Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00).



18AC-SRM-30-(115-1)34-CATI

Figure 1. Drag Load Member Attach Holes (Sheet 1)

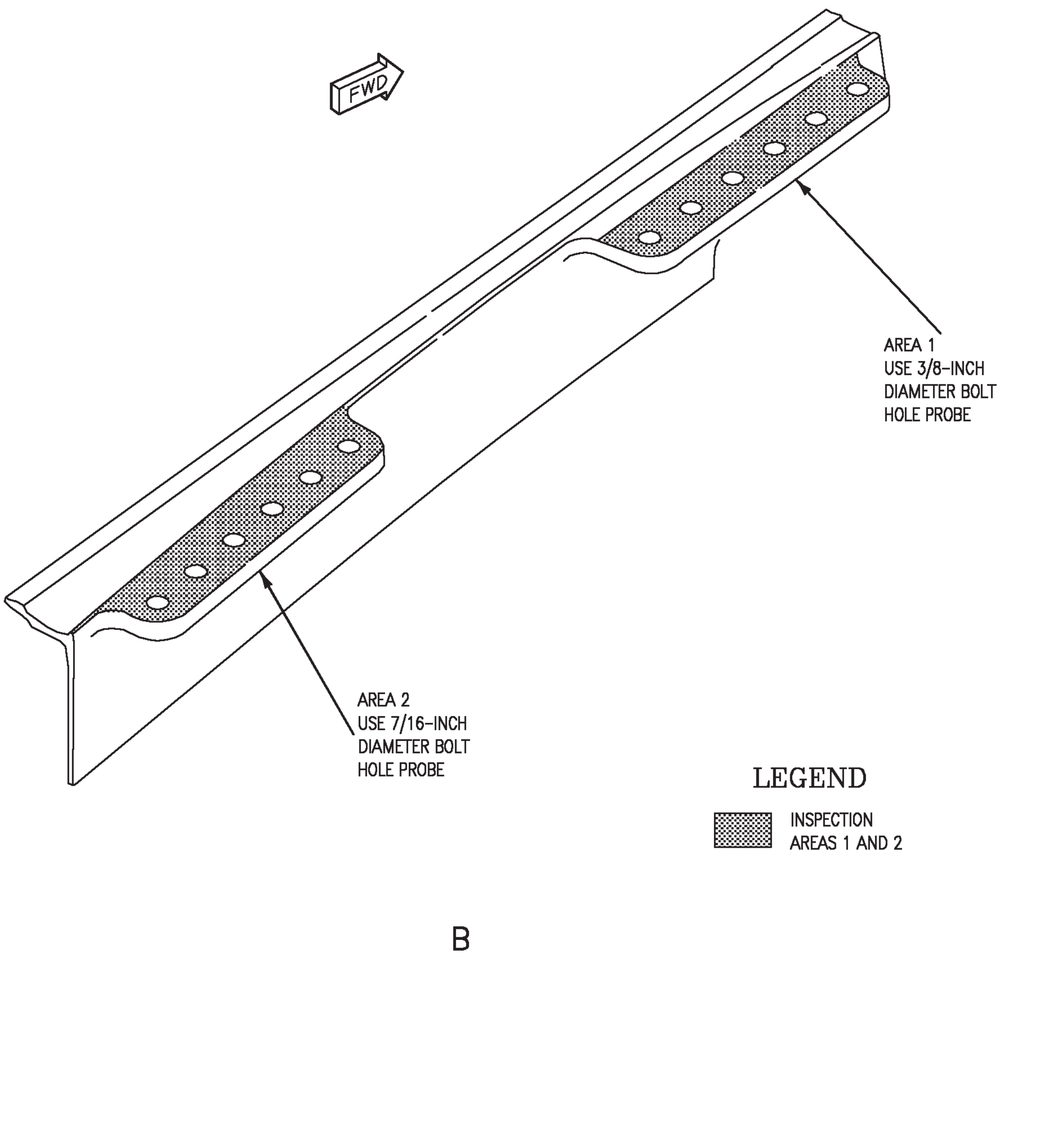


Figure 1. Drag Load Member Attach Holes (Sheet 2)

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

WING ROOT CLOSURE RIB, AFT SHEAR TIE BOX FLANGES FATIGUE CRACKS

PART NO. 74A110781

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Penetrant Method	WP004 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16
Aircraft Corrosion Control	A1-F18AC-SRM-500
Priming Procedures	WP011 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. **WING ROOT CLOSURE RIB.**

2. Wing root closure rib is machined 7075 aluminum alloy forging. Rib is coated with ion vapor deposition (IVD) aluminum coating. Surface finish is epoxy primer.

3. **DEFECTS.** Inspect for fatigue cracks in areas shown in figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
Fabricate, See Figure 2	EDM Notched Reference Standard, Aluminum
6193	Multiple Coil Eddy Current Surface Probe, Ideal Specialty Co.
1RR90F-6-1/2	Right Angle Surface Probe, GK Engineering

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, BLACK or RED	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

WARNING

Make sure safety precautions are met for electrical, static, grounding when using eddy current equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

9. **Equipment Settings/Standardization/Setup.**

a. For flat areas in aft shear tie box, See Figure 1, do ED520 Flaw Detector Setup (WP007 00) except as below:

(1) Use multiple coil eddy current surface probe.

(2) Standardize equipment using notch of aluminum reference standard, see figure 2, detail A.

b. For areas in aft shear tie box near edge radius, or fastener holes, see figure 1, Do ED520 Flaw Detector Setup (WP007 00) except use 1RR90F-6-1/2 right angle eddy current surface probe and circle template as probe guide (WP007 00).

10. **Inspection Procedure.**

a. For flat open areas in aft shear tie box, see figure 1, do Inspection Procedure (WP007 00) and refer to (NAVAIR 01-1A-16) except as below:

(1) Position probe on flat smooth surface of inspection area.

(2) Adjust BALANCE to set meter needle at 250 microamperes.

NOTE

When probe is moved near edge of part, fastener hole, or radius, meter needle may gradually move down scale. If required, BALANCE may be used to return meter needle to 250 microamperes and scan parallel to edge or radius.

(3) Scan inspection areas as shown in figure 1. Scan at constant speed, no faster than speed used

for standardization of equipment. After each scan, index probe 3/8-inch, 90° to scan direction, and continue next scan.

(4) Mark all areas with aircraft marking pencil where sharp down scale deflection of meter needle indicates a crack.

(5) Use right angle eddy current surface probe, and Inspection Procedure (WP007 00) to reinspect all marked areas for accuracy of locating crack(s) and to inspect right angle eddy current surface probe inspection area(s), see figure 1.

b. For areas next to edge radius, or fastener hole, see figure 1, do Inspection Procedure (WP007 00) except use right angle eddy current surface probe and circle template as probe guide (WP007 00).

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Fluorescent penetrant inspection may be used to verify indications detected by primary inspection method.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

13. **Preparation of Aircraft.** No special preparation required.

14. **Access.** Same as primary inspection method.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
—	14 X Magnifier
M-16	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are listed in parentheses.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2 D 1153	Dry Cleaning Solvent Methyl Isobutyl Ketone
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, CLASS A or B, BLACK or RED	Aircraft Marking Pencil
ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, LARGE	Chemical Gloves, Rubber Gloves
AA1048TY1CL1 GRIT4009X11	Aluminum Oxide Abrasive Cloth
MIL-C-87962, TYPE 1	Cleaning Cloth

15. **Preparation of Part.** Same as primary inspection method.

16. **Inspection Procedure.**

a. Do type 1, method C fluorescent penetrant inspection (WP004 00 and NAVAIR 01-1A-16).

b. After removing excess penetrant, spray thin film of developer on inspection surface.

c. Use black light and 14 X magnifier to view inspection area for cracks.

d. Evaluate indications, mark location of any defect with aircraft marking pencil and record.

17. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

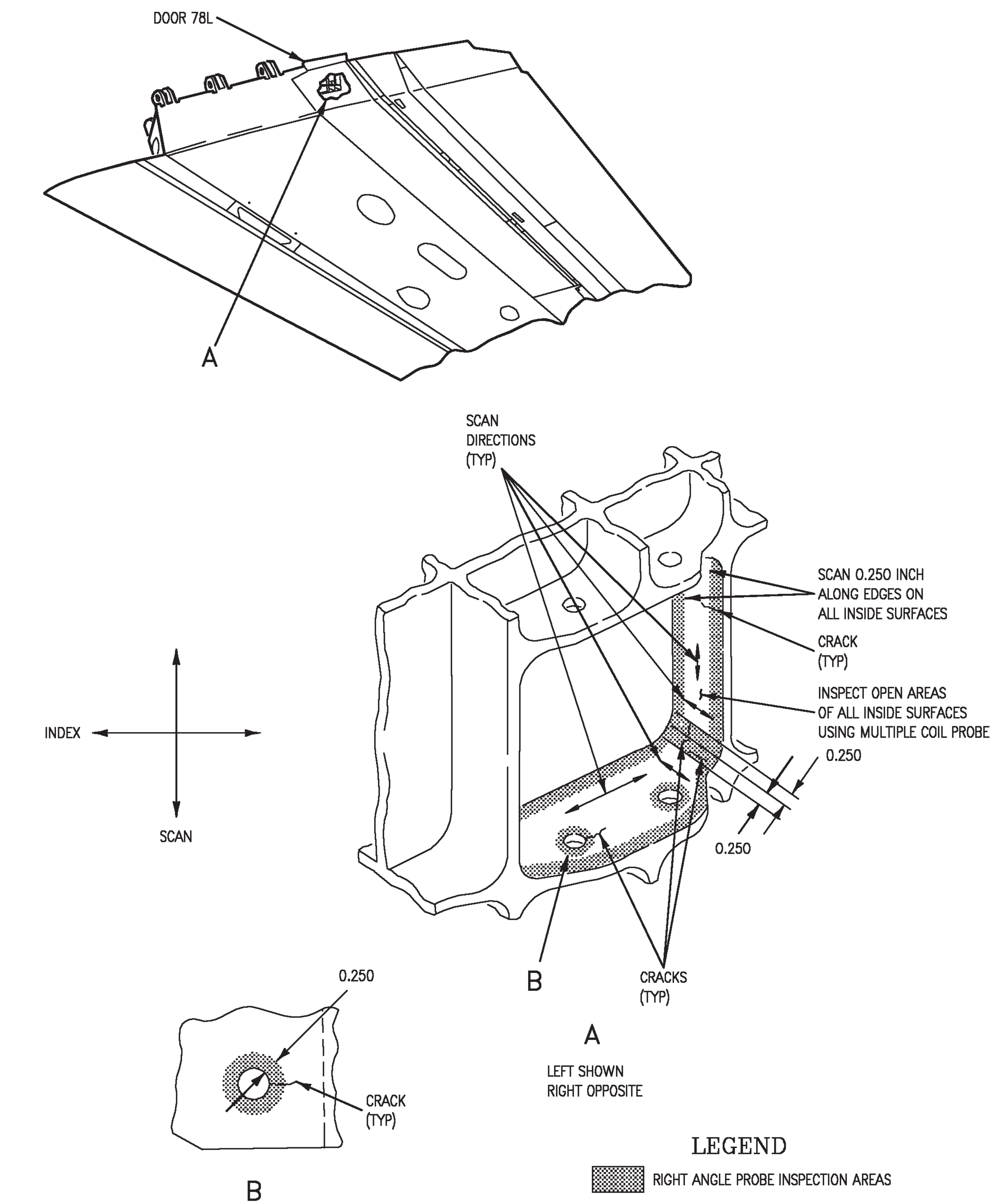
WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection material from part with solvent moistened cloth.

b. Have inspection area refinished, (A1-F18AC-SRM-500, WP011 00).

18. **SYSTEM SECURING.** Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00).



18AC-SRM-30-(116-1)34-CATI

Figure 1. Wing Root Closure Rib, Aft Shear Tie Box; Typical Defects, Scan Direction, and Inspection Area

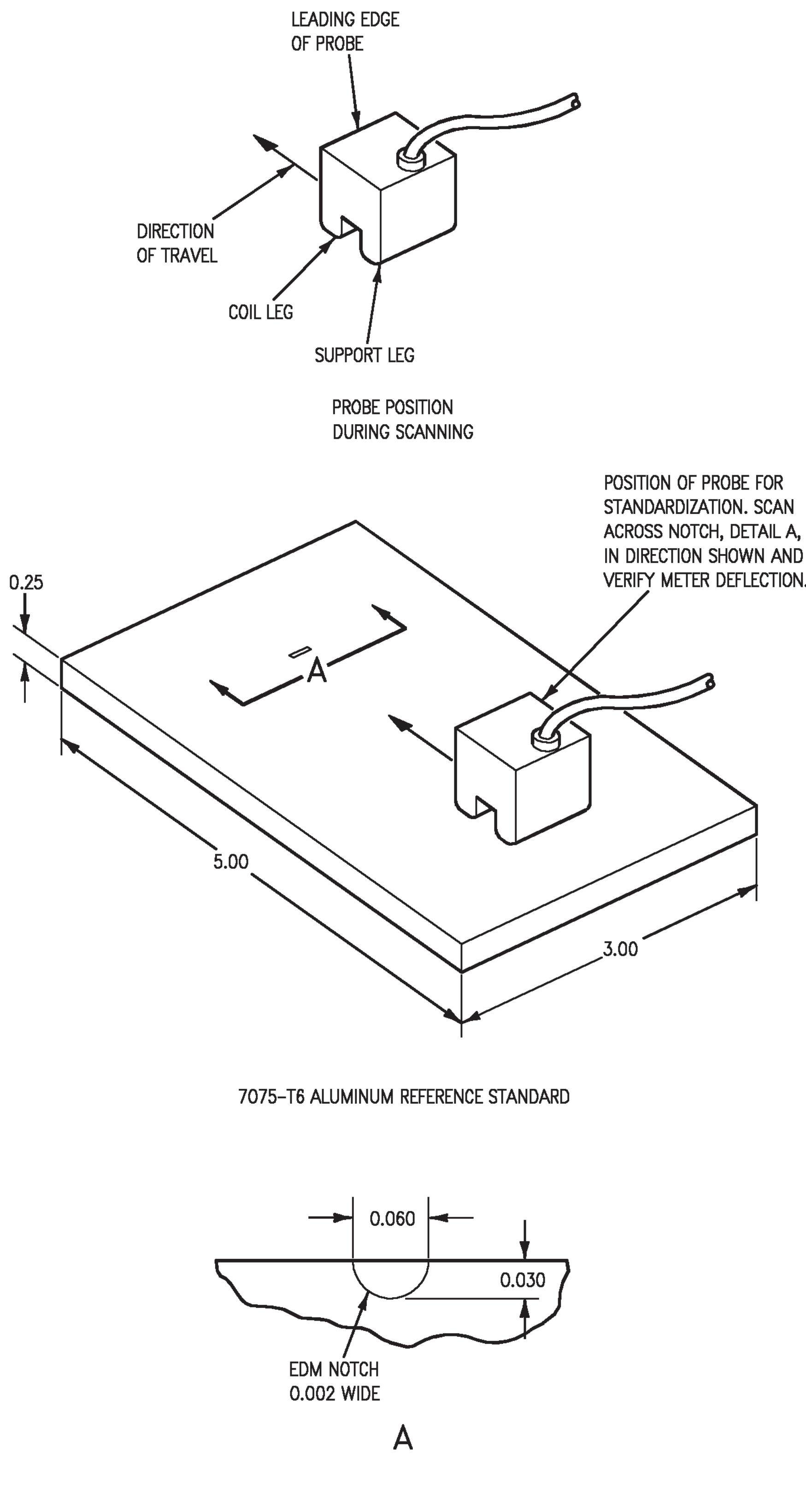


Figure 2. Standardization on EDM Notched Reference Standard

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

INNER WING ROOT UPPER AND LOWER ATTACH LUGS

FATIGUE CRACKS

UPPER PART NO. 74A110600

LOWER PART NO. 74A110601

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Plane Captain Manual	A1-F18AC-PCM-000
Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Finish System	WP012 00
Nondestructive Inspection	A1-F18AC-SRM-300
Penetrant Method	WP004 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. INNER WING ROOT UPPER AND LOWER ATTACH LUGS.

2. Inner wing root upper and lower attach lugs (attach lugs), see figure 1, are heat treated and machined from forged 6AL-4V titanium alloy. Installed in the attach lugs are force mated copper beryllium bushings. Surface finish is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect attach lugs for fatigue cracks in area surrounding the holes, see figures 1 and 2.

4. **PRIMARY INSPECTION METHODS.** Primary inspection methods are eddy current and fluorescent penetrant.

5. **Personnel Qualifications.** Personnel, doing these nondestructive inspections, should be qualified and certified to do eddy current and liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00).

8. **EDDY CURRENT METHOD.** See figures 1 and 2.

Support Equipment Required

Part Number or Type Designation	Nomenclature
NDT 18 (NDT 15) (EM3300)	Eddy Current Tester, CRT Display Automation, Ind.
3551F	Eddy Current Probe, NORTEC, 0.125 Dia., 2 MHz, Ferrite Shielded
—	Eddy Current Reference Standard, Titanium

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, BLACK or RED	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

9. **Preparation of Part.** Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

WARNING

Make sure safety precautions are met for electrical, static, grounding when using eddy current equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

10. **Equipment Settings/Standardization/Setup for Eddy Current Impedance Plane Instrument on Titanium Surface.** Using the NORTEC NDT 18 eddy current instrument (tester), standardize equipment as listed in steps below:

a. Connect 2.0 MHz probe to surface pencil tester.

b. Turn tester ON, allow 15 minutes warmup.

c. Set front face settings;

NOTE

Tester settings are given as an initial guide. Equipment differences may require use of alternate FINE FREQ, GAIN SENSITIVITY, FINE NULL, HORIZONTAL POSITION, and VERTICAL POSITION.

FREQ	1 MEG
FINE FREQ	2000 KHz
GAIN	25-35
SENSITIVITY	
HORIZONTAL	1
VERTICAL	1

STORE	ON
FOCUS	ADJUST AS REQUIRED
INTENSITY	ADJUST AS REQUIRED
FINE NULL	
X DIRECTION	APROX. MID SCALE
R DIRECTION	APROX. MID SCALE
HORIZONTAL POSITION	APROX. MID SCALE
VERTICAL POSITION	APROX. MID SCALE

d. Position probe on reference standard away from EDM notches or saw cut.

e. NULL tester.

(1) Press NULL and hold until flying dot on CRT stops moving.

(2) Position flying dot at intersection of x and y axes on CRT, center of display, using FINE NULL and also HORIZONTAL and VERTICAL POSITION as required.

NOTE

To avoid confusion during tester setup and use, erasing many traces displayed may be required. Erasing may be done by pressing ERASE.

f. Verify correct null point; turn ROTATION one full revolution. If center of circle formed by trace is not approximately centered on display or is more than one small division in diameter, adjust as below:

(1) If center of circle formed by trace is not centered on CRT, use HORIZONTAL POSITION, VERTICAL POSITION, and ROTATION to position center of circle trace on CRT, see figure 3, CRTs 1 and 2.

(2) If circle formed by trace is larger than one small division in diameter, recenter flying dot using FINE NULL, see figure 3, CRT 3. Verify circle diameter by turning rotation knob one full revolution. If circle formed by trace is still larger than one small division, repeat substeps f (1) and f (2).

g. Position lift-off trace line on horizontal axis by doing substeps below:

(1) With trace centered, slowly remove probe from reference standard and hold in air observing position of trace. Response represents lift-off trace line. If trace is not on horizontal axis, continue with substep (2). See figure 3, CRT 4.

(2) Repeatedly remove probe from reference standard and hold in air while simultaneously turning ROTATION, see figure 3, CRT 5. Continue until lift-off trace line is on horizontal axis with flying dot trace traveling from center of CRT to left of screen, see figure 3, CRT 6. A reasonable linear response should be observed although lift-off trace line may skew off the horizontal axis.

h. Reset VERTICAL SENSITIVITY to 0.5 and press ERASE.

i. Pass probe over 0.020 X 0.040 EDM notch on titanium reference standard. Upward response approximately one large division should form, see figure 3, CRT 7. GAIN may be used to get correct response height.

11. **Inspection Procedure for Eddy Current Impedance Plane Instrument on Titanium Surface.**

a. Slowly scan around attach hole in direction and area shown in figure 2. Upward response indicates crack, see figure 3, CRT 8. Downward response is caused by scanning over copper beryllium bushings, see figure 3, CRT 9, and figure 2.

b. Mark all areas that cause response on CRT of more than 1/2 large division in height. This indicates crack.

c. Mark suspect defect end points with sharp pointed aircraft marking pencil and record.

12. **PENETRANT METHOD.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
XMA101	Fluorescent Penetrant Inspection Kit, Portable
—	14 X Magnifier
M-16	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are listed in parentheses.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Ethyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
CCC-C-440, TYPE 1, CLASS 1	Cheesecloth

13. **Preparation of Part.**

CAUTION

Make sure inspection areas are not mechanically worked with abrasive paper or files before initial penetrant inspection to avoid smearing of material.

a. Have finish system removed from inspection area shown in figure 1 (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

14. **Inspection Procedure.** Do penetrant inspection.

a. Do type 1, method C fluorescent penetrant inspection (WP004 00) to detect fatigue cracks in areas shown in figure 1.

b. Remove excess penetrant by hand wiping.

(1) After penetrant dwell time is complete, excess penetrant shall be removed by wiping with dry cheesecloth.

WARNING

NOTE

Flourescent penetrant removal shall be done with aid of black light in a shaded or darkened area.

(2) To remove background color or flourescence, wipe inspection areas with solvent moistened cloth.

c. Spray thin film of developer on inspection areas.

d. Use black light and magnifier, if required, to view inspection areas for cracks.

e. Mark defect end points with sharp pointed aircraft marking pencil.

f. Record defects.

15. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone, are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection material from part with solvent moistened cloth.

b. Have finish system replaced in inspection areas (A1-F18AC-SRM-500, WP012 00).

16. **SYSTEM SECURING.** Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00).

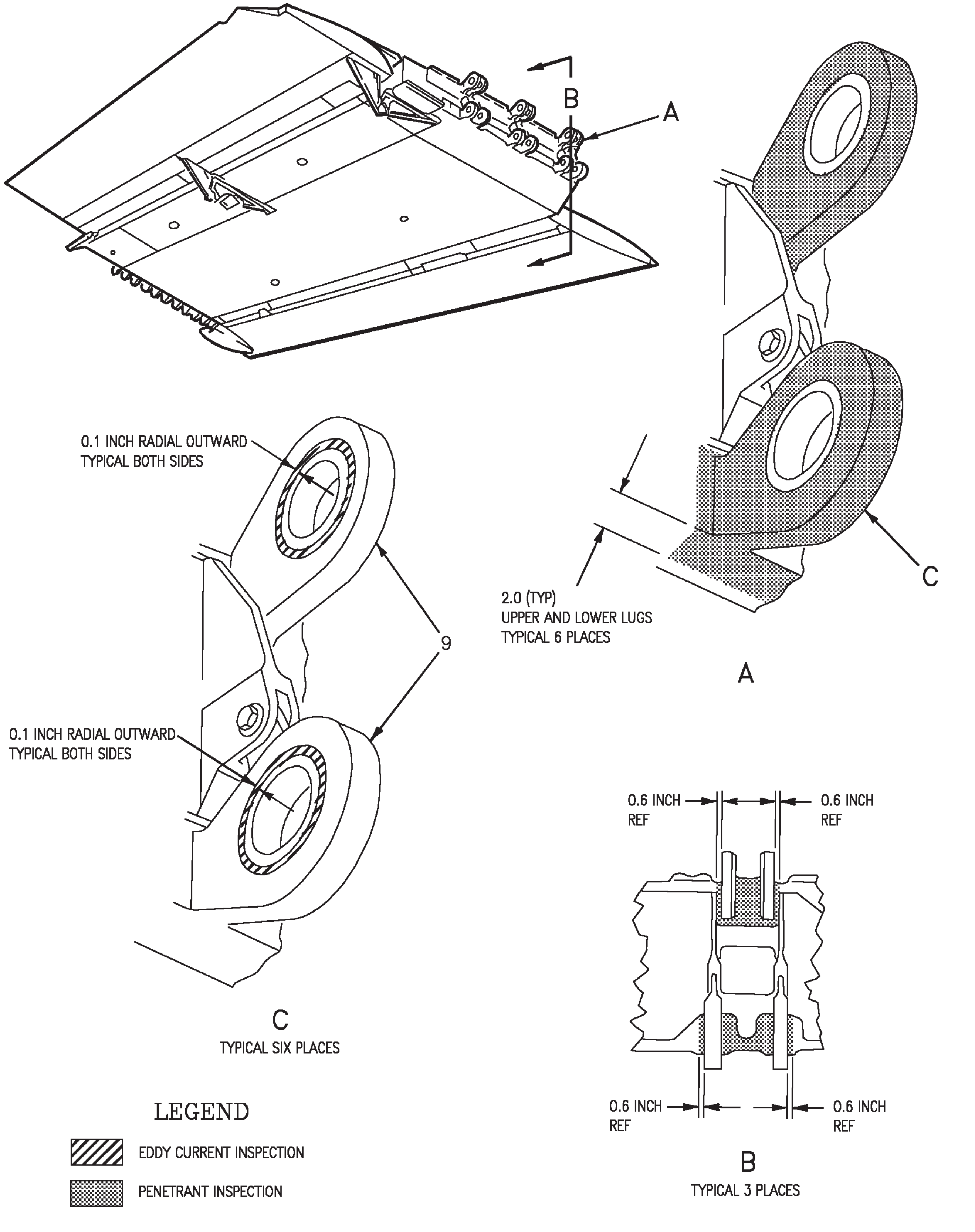


Figure 1. Inspection Areas

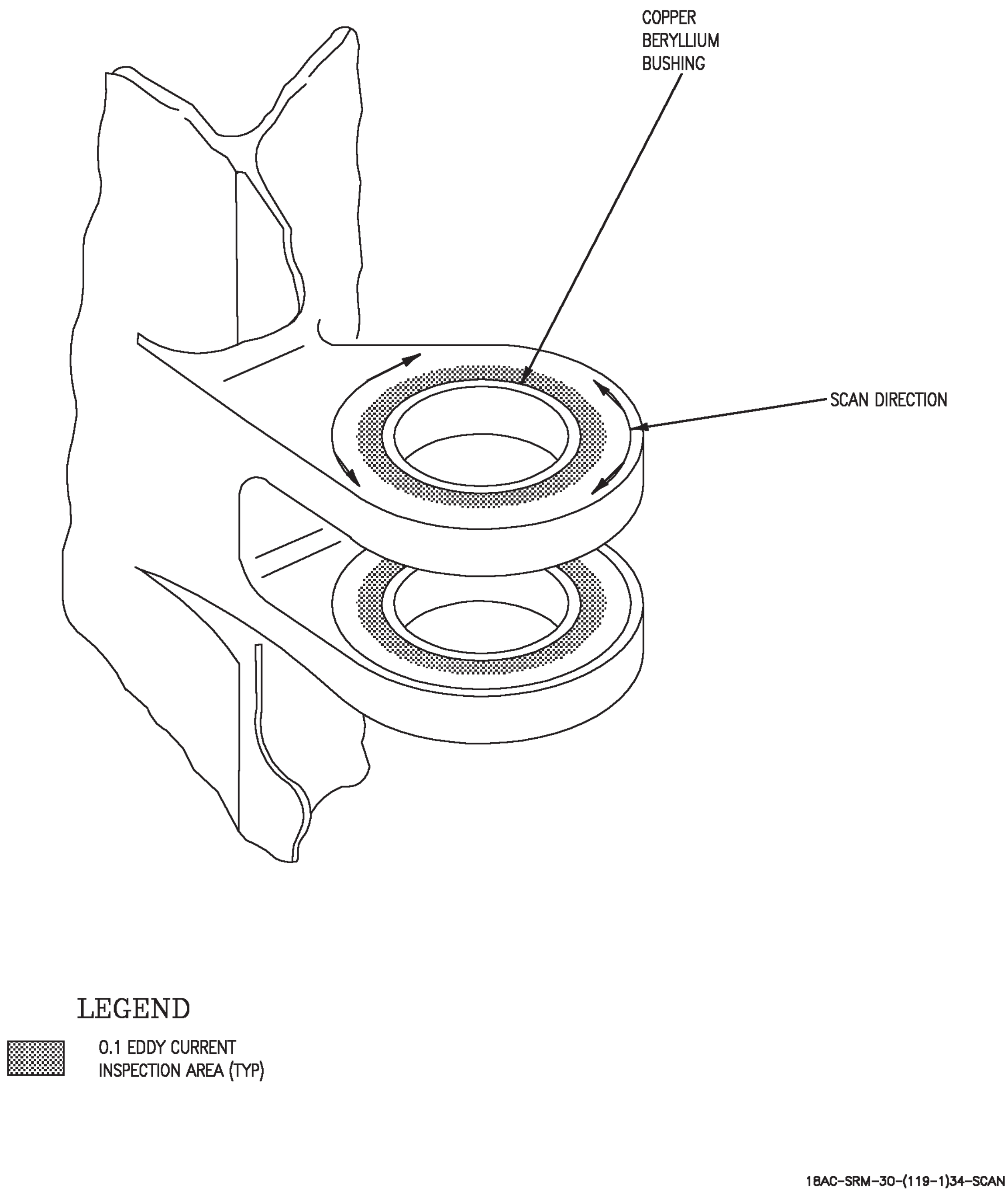
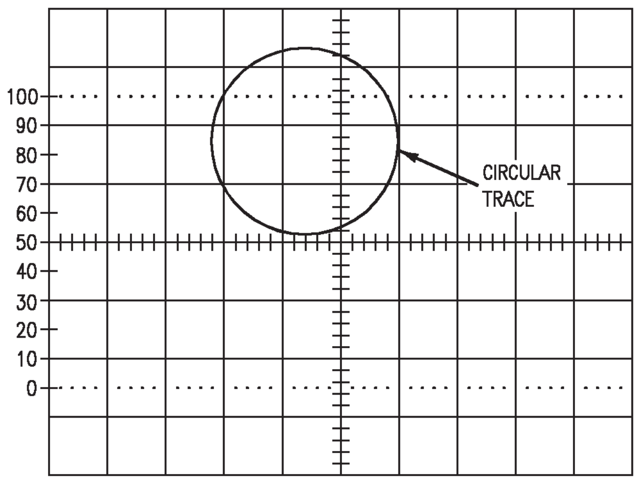
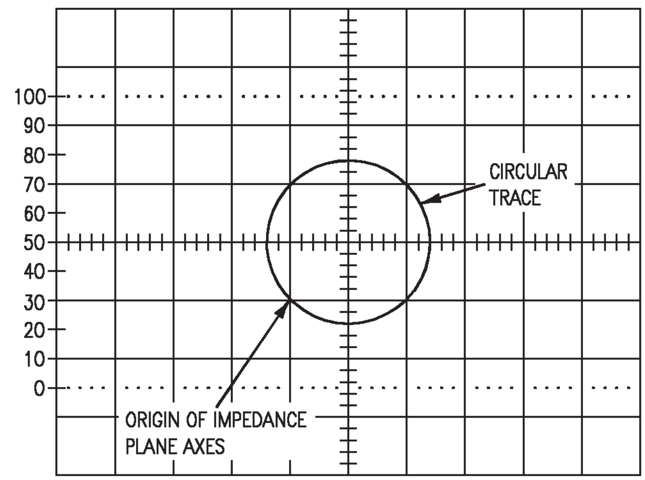


Figure 2. Scan Area and Direction



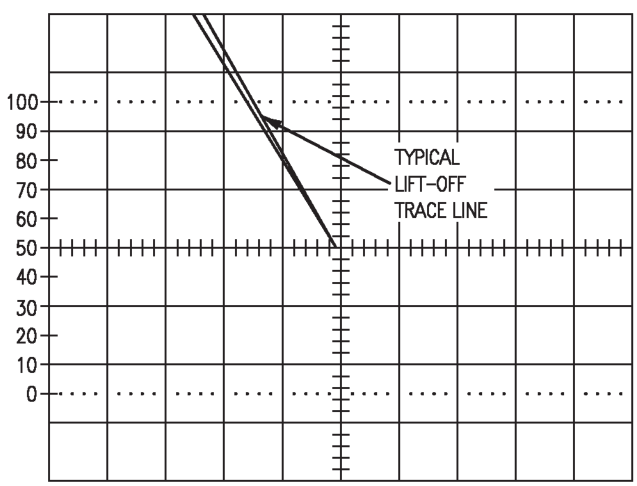
CRT 1

CENTER CIRCLE TRACE MADE BY ONE COMPLETE REVOLUTION OF CONTROL KNOB.



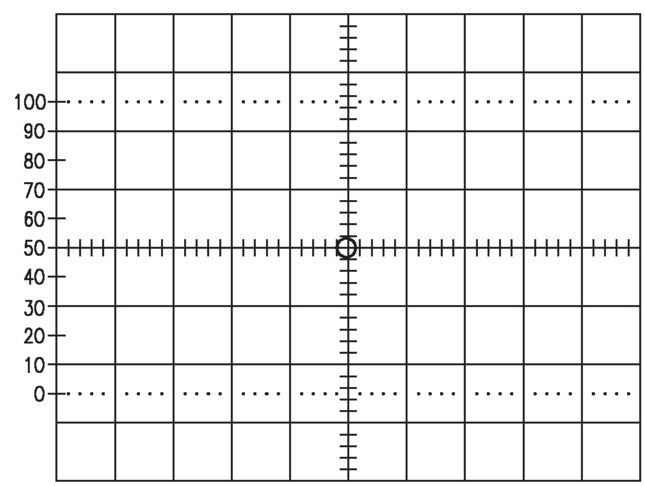
CRT 2

CENTER CIRCLE WITH HORIZONTAL OR VERTICAL POSITION CONTROL KNOBS.



CRT 4

LIFT-OFF TRACE LINE



CRT 3

CIRCLE MUST BE LESS THAN ONE SMALL DIVISION SET WITH FINE NULL CONTROL KNOBS.

18AC-SRM-30-(120-1)34-CATI

Figure 3. Typical Setup Presentations (Sheet 1)

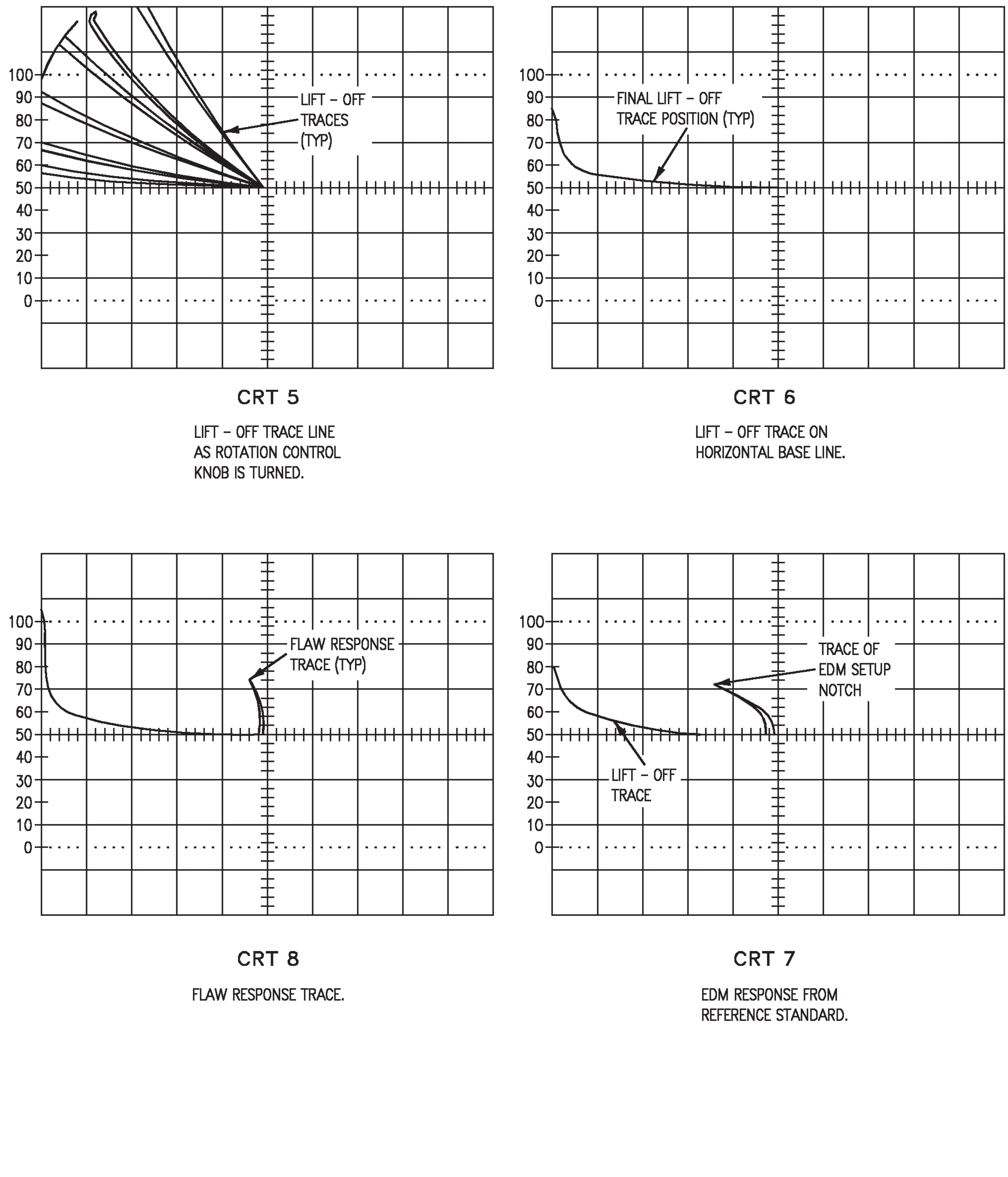
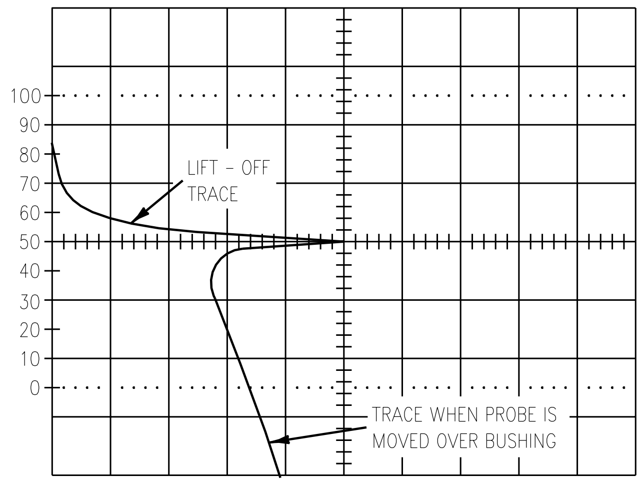


Figure 3. Typical Setup Presentations (Sheet 2)



CRT 9

RESPONSE CAUSED BY
SCANNING OVER COPPER
BERYLLIUM BUSHING.

18AC-SRM-30-(120-3)-CADD

Figure 3. Typical Setup Presentations (Sheet 3)

INTERMEDIATE MAINTENANCE

INNER WING UPPER AND LOWER TITANIUM SPLICE FITTING AREAS,

SKIN TO TITANIUM SPLICE FITTING UNBONDS, AND SKIN DELAMINATIONS

UPPER SKIN PART NO. 74A110600

LOWER SKIN PART NO. 74A110601

Reference Material

Plane Captain Manual A1-F18AC-PCM-000
Naval Aviation Maintenance Program .... OPNAVINST 4790.2
Nondestructive Inspection........ A1-F18AC-SRM-300
General Information WP003 00
Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material WP008 03
Pulse-Echo, longitudinal Contact With Delay Line, for Composite Laminate Material WP008 12
Line Maintenance Procedures........ A1-F18AC-LMM-000

Alphabetical Index

Subject **Page No.**

Record of Applicable Technical Directives

None

1. **INNER WING UPPER AND LOWER TITANIUM SPLICE FITTING AREAS.**

2. Inner wing upper and lower surfaces, see figures 1 and 2, are graphite epoxy composite laminate material with 6Al-4V titanium stepped splice fitting. Surface finish is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect for skin to titanium splice fitting unbonds and skin delaminations. For areas over first three inboard steps of root area and areas backed by substructure, inspect for delaminations in laminate. Examples of step area unbonds and delaminations that may develop in a laminate assembly are contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and

certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation Of Aircraft.**

NOTE

To avoid inaccurate ultrasonic responses, fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

a. Have aircraft fueled (A1-F18AC-PCM-000). Fuel must be in contact with inner surface of upper and lower wing skins in inspection area.

b. Jack one wing to move air bubbles, if any, away from inspection area (A1-F18AC-LMM-000).

7. **Access.** No special access required.

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector, Sonic Instruments
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A7101 or EQUIVALENT	0°, 0.50 Dia, 1 MHz, Contact, Delay Line, Search Unit
57A4244-30	Test Block, Aluminum, IIW-2

Materials Required

NOTE

Alternate item part numbers are shown indented.

Part Number or Type Designation	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone

9. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. On upper and lower surfaces of inner wing, locate and identify inspection areas as shown in figures 1 and 2. Accurately locate splice fitting steps, spars, ribs, fuel, electrical, and hydraulic lines.

10. **Equipment Settings/Standardization/Setup For Titanium Splice Fitting Areas Not Over Substructure.** See figures 1 and 2. Make equipment standardization per substeps below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

a. Connect search unit to Microdot cable.

b. Plug BNC end of microdot cable into ultrasonic flaw detector (tester) T or R BNC jack.

c. Turn tester ON. Allow 15 minutes warm-up.

d. Set tester front face settings:

NOTE

Tester settings given are initial setup guide. Equipment differences may require use of alternate COARSE SWEEP RANGE, FREQ., FINE GAIN, COARSE GAIN, REP. RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. Optimum setup may produce changes in these initial settings.

COARSE SWEEP RANGE	20.0 INCHES
ATTENUATORS	ALL IN
FILTER	OFF
COARSE SWEEP DELAY	0 - 3 INCHES
FREQ	SAME AS SEARCH UNIT
MODE	PULSE ECHO
FINE GAIN	APPROX MID SCALE
COARSE GAIN	APPROX 2
REP RATE	AUTO
FINE SWEEP RANGE	APPROX 0 (MIN.)
DAMPING	APPROX 0
REJECT	APPROX 0
VIDEO DISPLAY	FULL WAVE

e. With search unit held in air or face up on work surface, adjust FINE SWEEP DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 3, CRT 1.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

g. Apply couplant to inspection area, position search unit on surface of block.

h. Position search unit on surface of test block as shown in figure 3.

i. Adjust FINE SWEEP RANGE, and COARSE SWEEP RANGE, if required, so first back surface response is located at 1 on horizontal baseline.

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

j. Adjust GAIN so first back surface response is 100 percent CRT height, see figure 3, CRT 1.

k. Adjust DAMPING, as required. After this adjustment, make sure first back surface response is 100 percent CRT height and located at 1 on horizontal baseline.

11. **Inspection Procedure For Titanium Splice Fitting Areas Not Over Substructure.**

a. Inspect steps A, B, and C of upper and lower titanium root splice fitting area of figures 1 and 2 per substeps below:

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

(1) Add 56 dB GAIN.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

(2) Apply couplant to surface of inspection area.

(3) Scan inspection areas of steps A, B, and C on upper and lower surfaces in direction, shown in figures 1 and 2. After each scan, index 0.250 inch in direction, shown in figures 1 and 2. Use straight edge as guide to allow continual monitoring of CRT.

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark all areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added. See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 03) to determine if above marked areas are result of skin delaminations on outer surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

b. Inspect steps D, E, and F of upper and lower titanium root splice fitting area of figures 1 and 2 per substeps below:

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

(1) Add 44dB GAIN.

(2) Apply couplant to surface of inspection areas.

(3) Scan inspection areas of steps D, E, and F on upper and lower surfaces in direction shown in Figures 1 and 2. After each scan, index 0.250 inch in direction shown in figures 1 and 2. Use straight edge as guide to allow continual monitoring of CRT

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark all areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added . See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 03) to determine if above marked areas are result of skin delaminations on outer surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

c. Inspect steps of titanium splice fitting in upper and lower outboard pylon and lower inboard pylon areas of figures 1 and 2 per substeps below:

NOTE

GAIN may be adjusted by changing FINE GAIN, COARSE GAIN, or by toggling ATTENUATORS.

(1) Add 36dB GAIN.

(2) Apply couplant to surface of inspection area(s).

(3) Scan areas of outboard pylon area titanium steps on upper and lower skins in direction shown in figure 1. Index 0.250 inch in direction

shown in figure 1. Use straight edge as guide to allow continual monitoring of CRT. Scan only those areas backed by substructure.

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark all areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added . See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 03) to determine if above marked areas are result of skin delaminations on outer surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

12. **Equipment Settings/Standardization/Setup For Composite Laminate Skin to Titanium Splice Fitting Areas Over Steps G, H, and J of Splice Fitting Area and Over Substructure.**

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores (A1-F18AC-PCM-000).

a. Do Equipment Settings/Standardization/Setup For Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material up to 0.190 inch (WP008 03).

b. If required, use setup and mapping procedure with larger horizontal baseline deflection. To get larger horizontal baseline setup, set original FBH reference further apart on CRT horizontal baseline. Compute new unit of composite material per applicable CRT baseline division and with (WP008 03).

13. **Inspection Procedure For Composite Laminate Skin to Titanium Splice Fitting Areas Over Steps G, H, and J of Splice Fitting Area and Over Substructure.**

a. Inspect steps G, H, and J of upper and lower titanium splice fitting area and over structure of figures 1 and 2 per substeps below:

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

(1) Apply couplant to inspection area.

(2) Position search unit on skin of inspection area.

(3) Make sure leading edge of skin to titanium interface response is at correct location on horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use figures 1 and 2 to identify approximate thickness of skin on surface over titanium splice fitting.

(4) Scan skin along each step, monitoring position of skin to titanium interface response, see figure, 5 CRT 1.

(5) Delamination is indicated by unexplainable thickness change or loss of response from skin to titanium splice fitting interface.

(6) Mark all areas with aircraft marking pencil which indicate delamination response, see figure 5, CRT 2. Examples of other delamination responses are found in (WP008 03).

b. Do paragraph 20.

14. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A7101 or EQUIVALENT	0°,0.5 Dia, 1 MHz, Contact, Delay Line, Search Unit
57A4244-30	Test Block, Aluminum, IIW-2

Materials Required

NOTE

Alternate item part numbers are shown indented.

Part Number or Type Designation	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

15. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with solvent moistened cloth to make sure inspection area(s) is free of contamination or foreign material.

b. On upper and lower surfaces of inner wing, locate and identify inspection areas as shown in figures 1 and 2. Accurately locate splice fitting steps, spars, ribs, fuel, electrical, and hydraulic lines.

16. **Equipment Settings/Standardization/Setup For Titanium Splice Fitting Areas Not Over Substructure.** See figures 1 and 2. Make equipment standardization per substeps below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores (A1-F18AC-PCM-000).

a. Connect search unit to Microdot cable.

b. Plug BNC end of microdot cable into ultrasonic flaw detector (tester) T or R BNC jack.

c. Turn tester ON. Allow 5 minutes warm-up.

d. Set tester front face settings:

NOTE

Tester settings given are initial guide. Equipment differences may require use of alternate REP. RATE, DAMP, FREQ., GAIN, REJECT, and HORIZONTAL SWEEP DELAY and LENGTH.

REP. RATE	AUTO
VOLT	FULL
DAMP	MIN.
FREQ.	1MHz
MODE	ECHO
GAIN (dB)	52 (dB)
COURSE GAIN	5
FINE GAIN	2
VIDEO	
FILTER	3
MODE	F.W.
REJECT	0
SYNC	REP. REP.
HORIZONTAL SWEEP DELAY	
COURSE	50
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	5
FINE	7.2
POLARITY	OFF
DISTANCE ECHO CORRECTION	OFF

e. With search unit held in air or face up on work surface, adjust HORIZONTAL SWEEP FINE DELAY setting until initial pulse is located at zero on CRT horizontal baseline. See figure 3, CRT 1.

NOTE

Initial and echo pulses shown in figure may differ from actual wave shape.

f. Adjust VERTICAL, if required, to set sweep trace coincident with CRT horizontal baseline.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

g. Apply couplant to inspection area, position search unit on surface of block.

h. Position search unit on surface of test block as shown in figure 3.

i. Adjust HORIZONTAL SWEEP FINE LENGTH, and COARSE LENGTH, if required, so first back surface response is located at 1 on horizontal baseline.

j. Adjust FINE GAIN so first back surface response is 100 percent CRT height, see figure 3, CRT 1.

k. Adjust DAMPING, as required. After this adjustment, make sure first back surface response is 100 percent CRT height and located at 1 on horizontal baseline.

17. **Inspection Procedure For Titanium Splice Fitting Areas Not Over Substructure.**

a. Inspect steps A, B, and C of upper and lower titanium root splice fitting area of figures 1 and 2 per substeps below:

(1) Add 56 dB GAIN using COARSE and FINE dB GAIN controls.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

(2) Apply couplant to surface of inspection areas.

(3) Scan inspection areas of steps A, B, and C on upper and lower surfaces in direction, shown in figures 1 and 2. After each scan, index 0.250 inch in direction, shown in figures 1 and 2. Use straight edge as guide to allow continual monitoring of CRT.

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark all areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added. See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 12) to determine if above marked areas are result of skin delaminations on outer surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

b. Inspect steps D, E, and F of upper and lower titanium root splice fitting area of figures 1 and 2 per substeps below:

(1) Add 44dB GAIN using COARSE and FINE dB GAIN controls.

(2) Apply couplant to surface of inspection areas.

(3) Scan inspection areas of steps D, E, and F on upper and lower surfaces in direction shown in Figures 1 and 2. After each scan, index 0.250 in direction shown in figures 1 and 2. Use straight edge as guide to allow continual monitoring of CRT

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added. See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 12) to determine if above marked areas are result of skin delaminations on outer surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

c. Inspect steps of titanium splice fitting in upper and lower outboard pylon and lower inboard pylon areas of figures 1 and 2 per substeps below:

(1) Add 36dB GAIN using COARSE and FINE dB GAIN controls.

(2) Apply couplant to surface of inspection area(s).

(3) Scan areas of outboard pylon area titanium steps on upper and lower skins in direction shown in figure 1. Index 0.250 in direction shown in figure 1. Use straight edge as guide to allow continual monitoring of CRT. Scan only those areas backed by substructure.

NOTE

Fuel must be in contact with inner surface of upper and lower wing skins. Ultrasound cannot be transmitted through air bubbles.

(4) Monitor for wing skin/fuel interface response or responses from fuel, electrical, and hydraulic lines. See figure 4 CRT's 1 through 6 for good typical received responses.

(5) Mark all areas with aircraft marking pencil where received response to right of 3 on horizontal baseline falls below 10 percent CRT height, even with another 8 dB of gain added. See figure 4, CRT 7.

(6) Use Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material (WP008 12) to determine if above marked areas are result of skin delaminations on outer

surface of skin over titanium splice fitting area. Delamination in this area is indicated by unexplainable thickness change or loss of received response from outer skin to titanium splice fitting interface.

18. **Equipment Settings/Standardization/Setup For Composite Laminate Skin to Titanium Splice Fitting Areas Over Steps G, H, and J of Splice Fitting Area and Over Substructure.**

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores (A1-F18AC-PCM-000).

a. Do Equipment Settings/Standardization/Setup For Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material up to 0.190 inch (WP008 12).

b. If required, use setup and mapping procedure with larger horizontal baseline deflection. To get larger horizontal baseline setup, set original FBH reference further apart on CRT horizontal baseline. Compute new unit of composite material per applicable CRT baseline division and with (WP008 12).

19. **Inspection Procedure For Composite Laminate Skin to Titanium Splice Fitting Areas Over Steps G, H, and J of Splice Fitting Area and Over Substructure.** Inspect steps G, H, and J of upper and lower titanium splice fitting area and over structure of figures 1 and 2 per substeps below:

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

a. Apply couplant to inspection area.

b. Position search unit on skin of inspection area.

c. Make sure leading edge of skin to titanium interface response is at correct location on horizontal baseline when peak amplitude is 80 to 90 percent CRT height. Use figures 1 and 2 to identify approximate thickness of skin on surface over titanium splice fitting.

d. Scan skin along each step, monitoring position of skin to titanium interface response, see figure 5, CRT 1.

e. Delamination is indicated by unexplainable thickness change or loss of response from skin to titanium splice fitting interface.

f. Mark areas with aircraft marking pencil which indicate delamination response, see figure 5, CRT 2. Examples of other delamination responses are found in (WP008 12).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

20. **POST INSPECTION CLEANING AND CORROSION CONTROL.** After recording any defects, clean inspection marks and couplant from inspection area(s) with solvent moistened cloth.

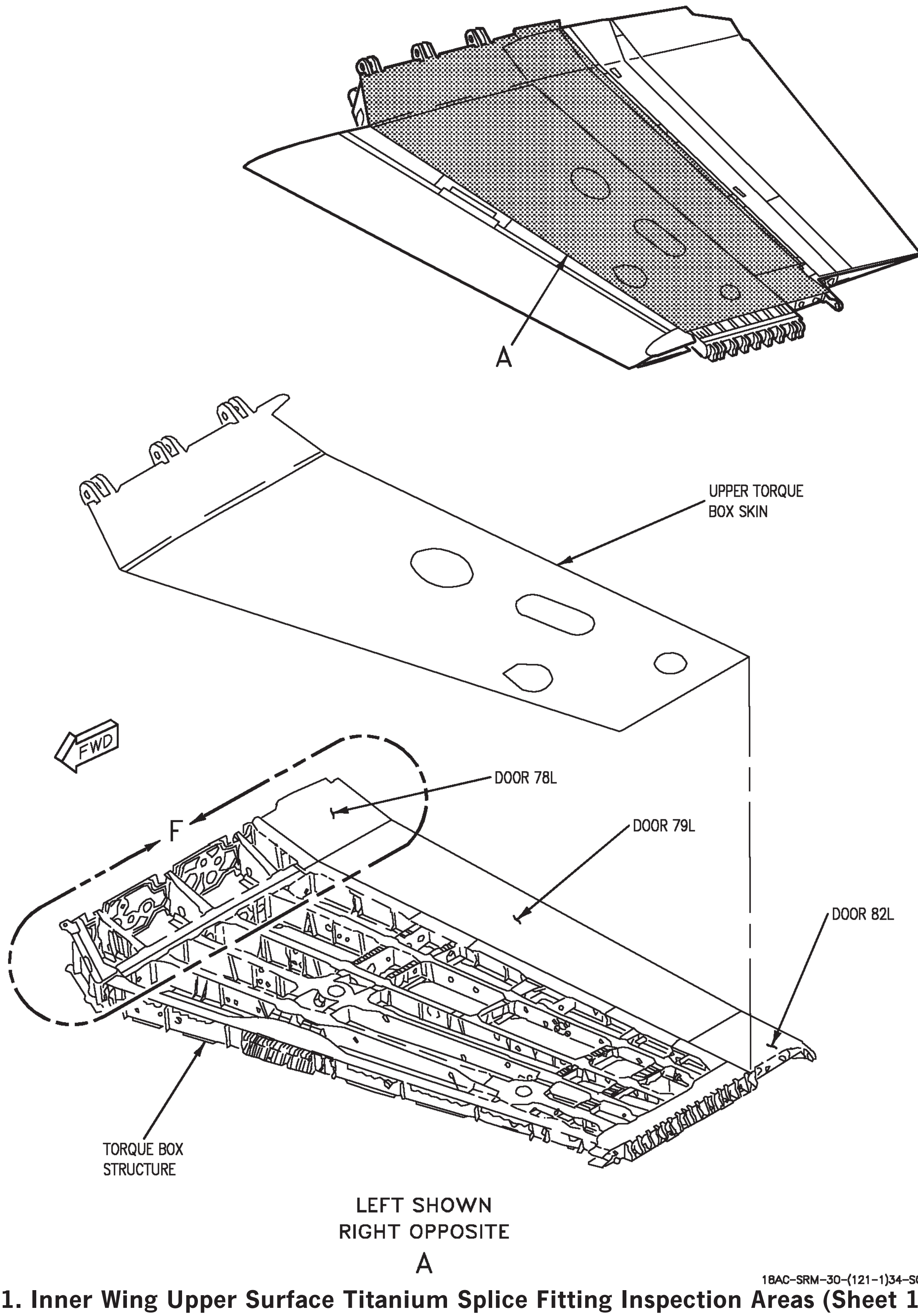


Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 1)

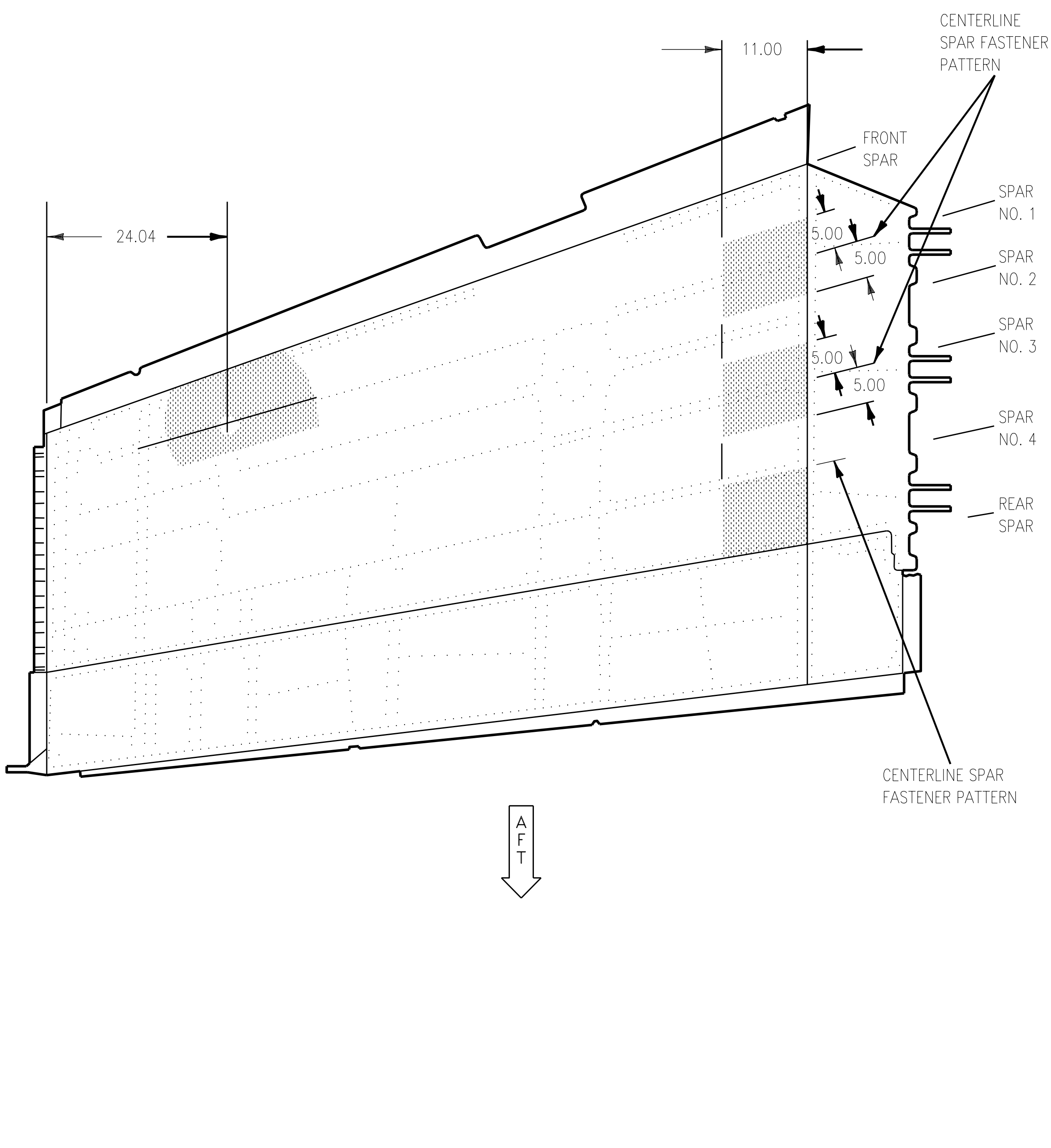


Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 2)

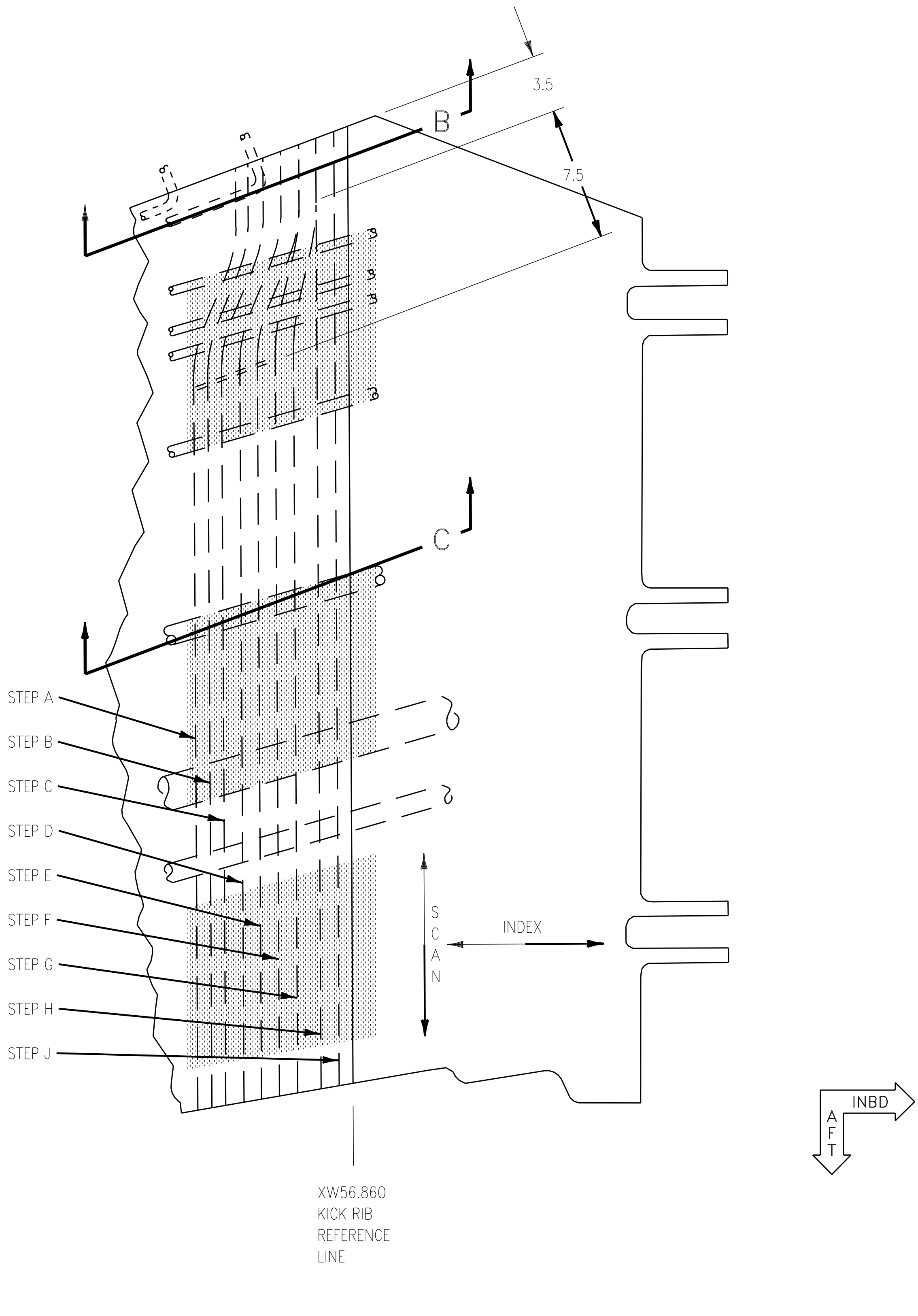
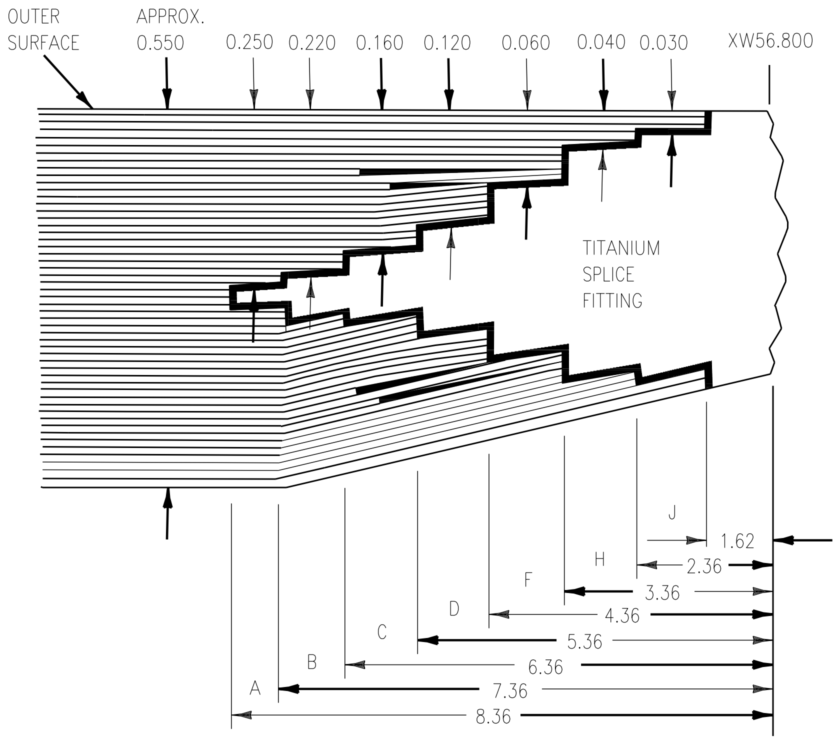
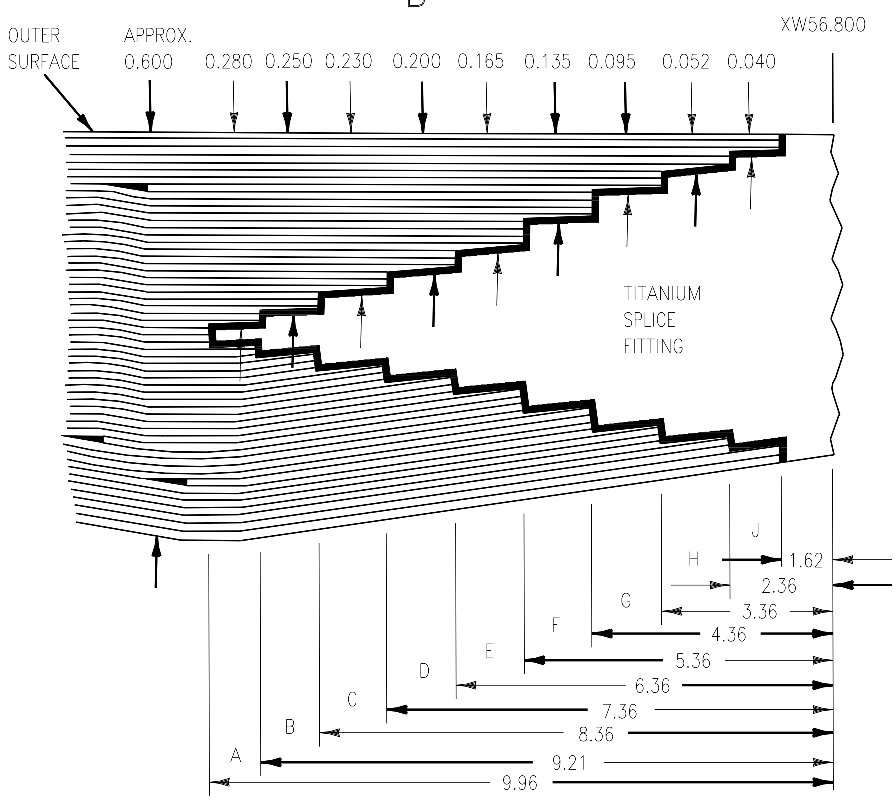


Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 3)



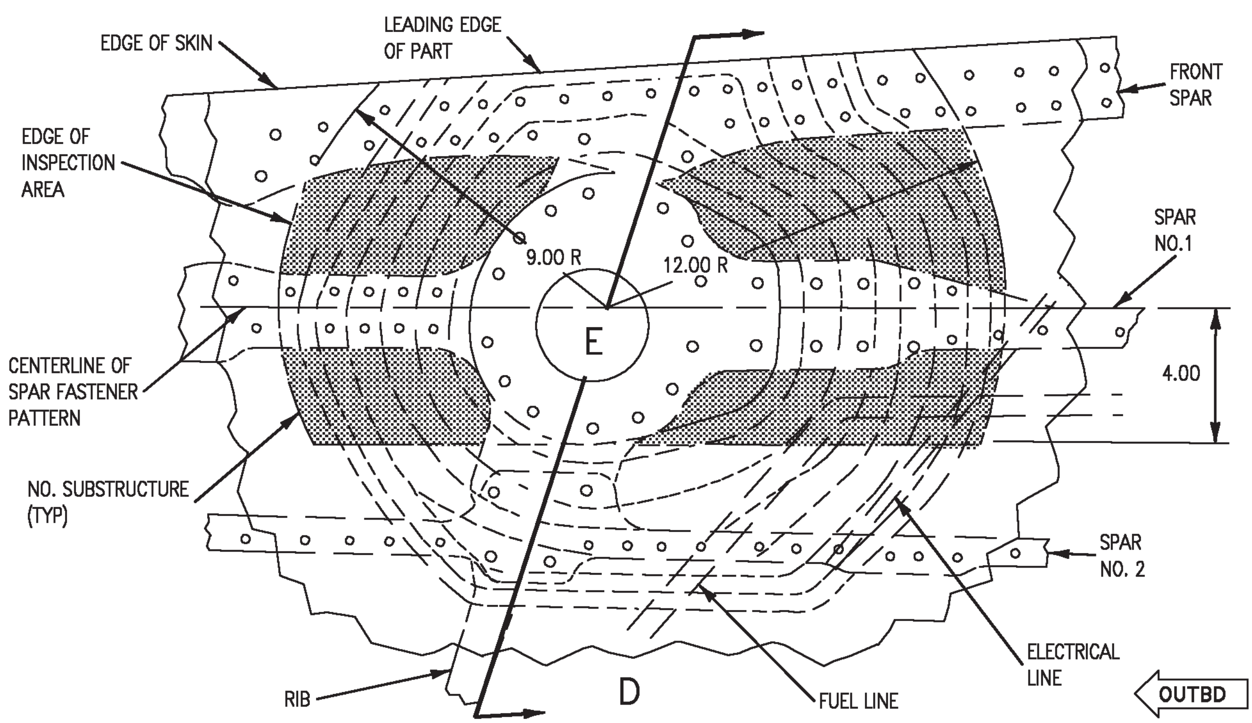
B



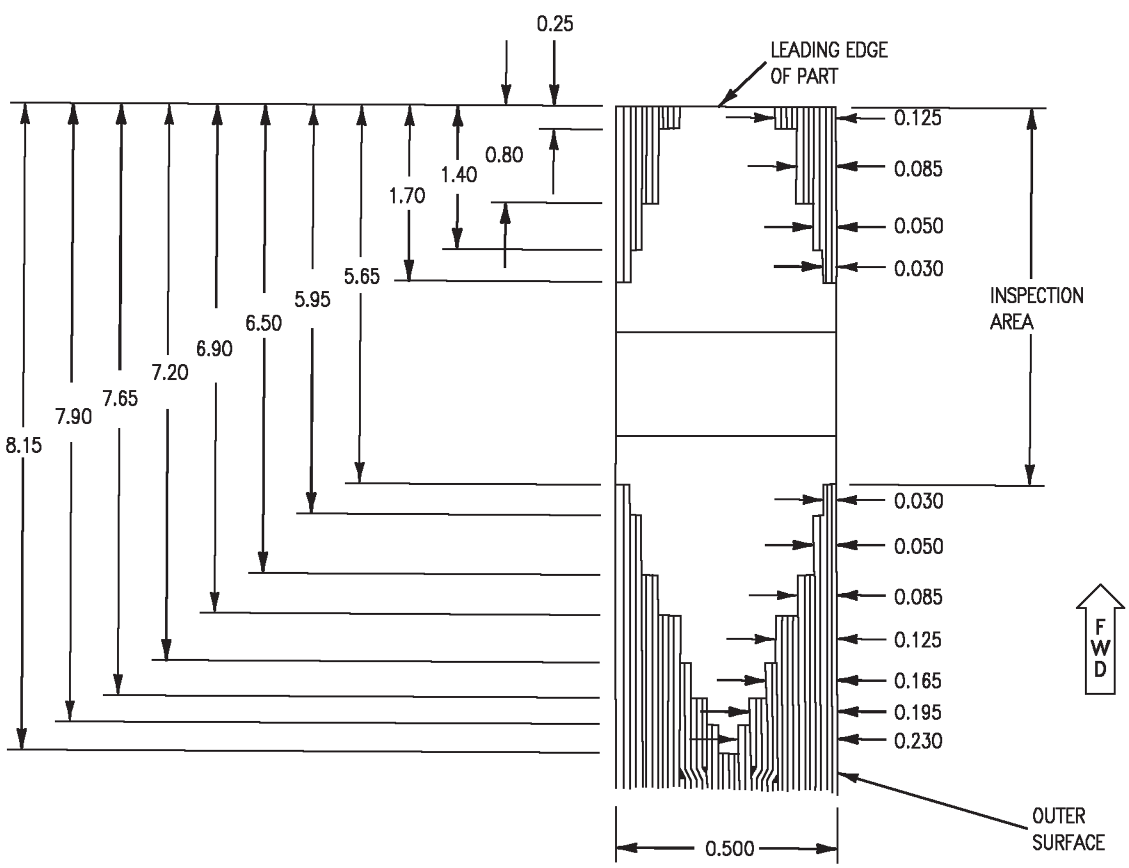
C

18AC-SRM-30-(121-4)-SCAN

Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 4)



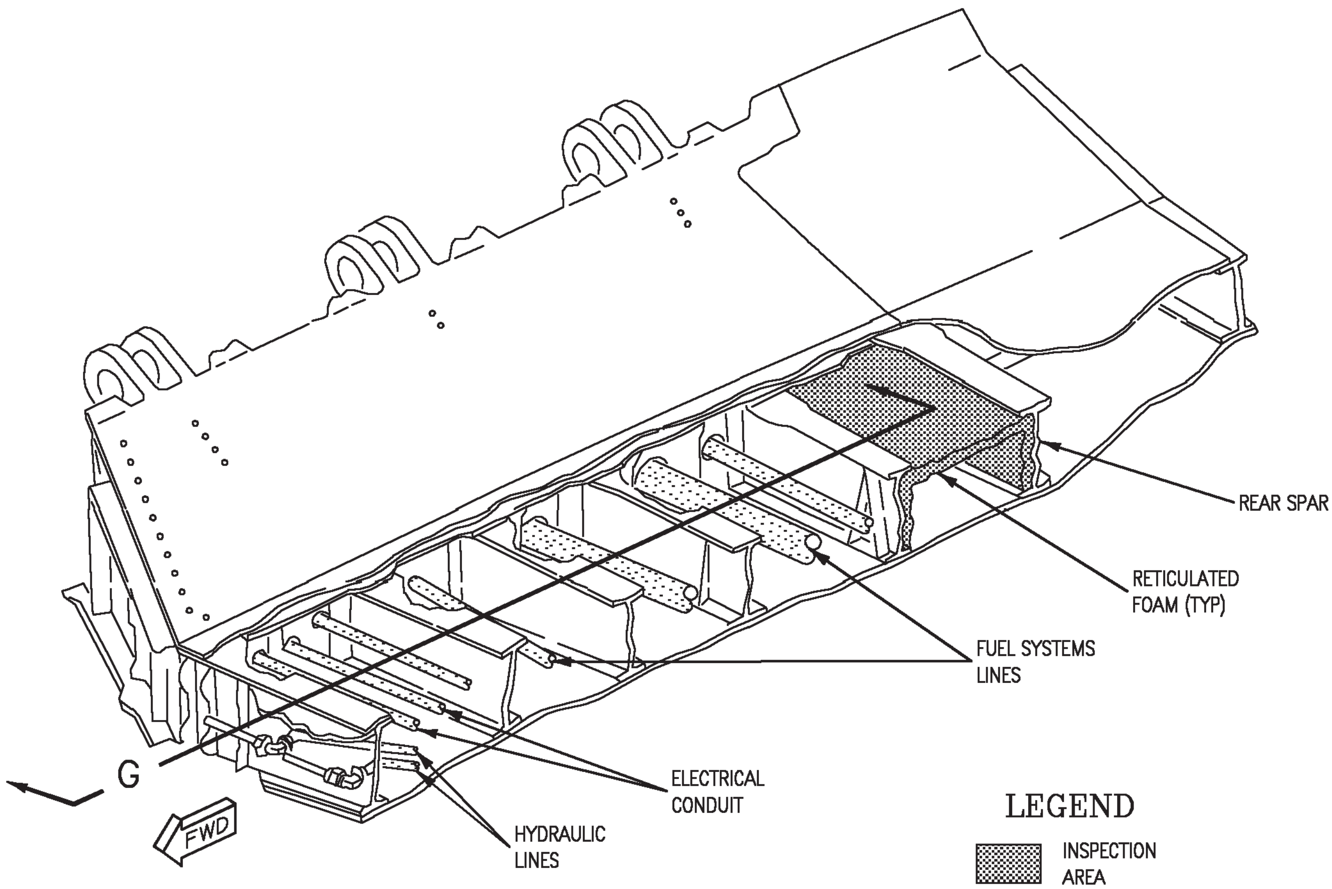
OUTBOARD PYLON SPLICE FITTING AREA



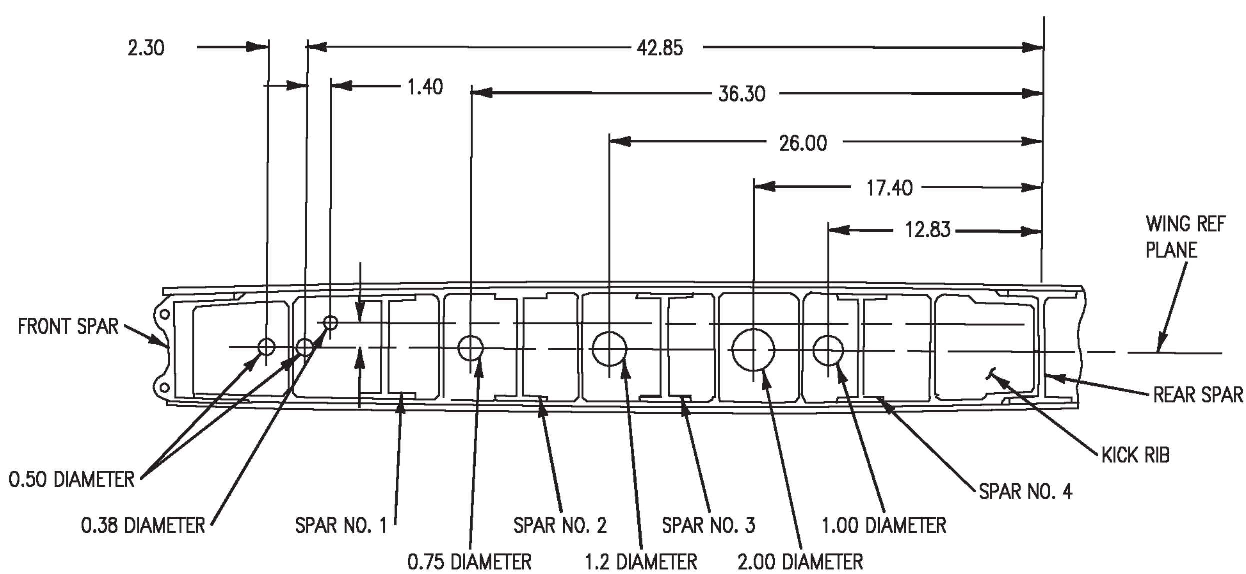
E

18AC-SRM-30-(121-5)-SCAN

Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 5)



F



G

18AC-SRM-30-(121-6)34-SCAN

Figure 1. Inner Wing Upper Surface Titanium Splice Fitting Inspection Areas (Sheet 6)

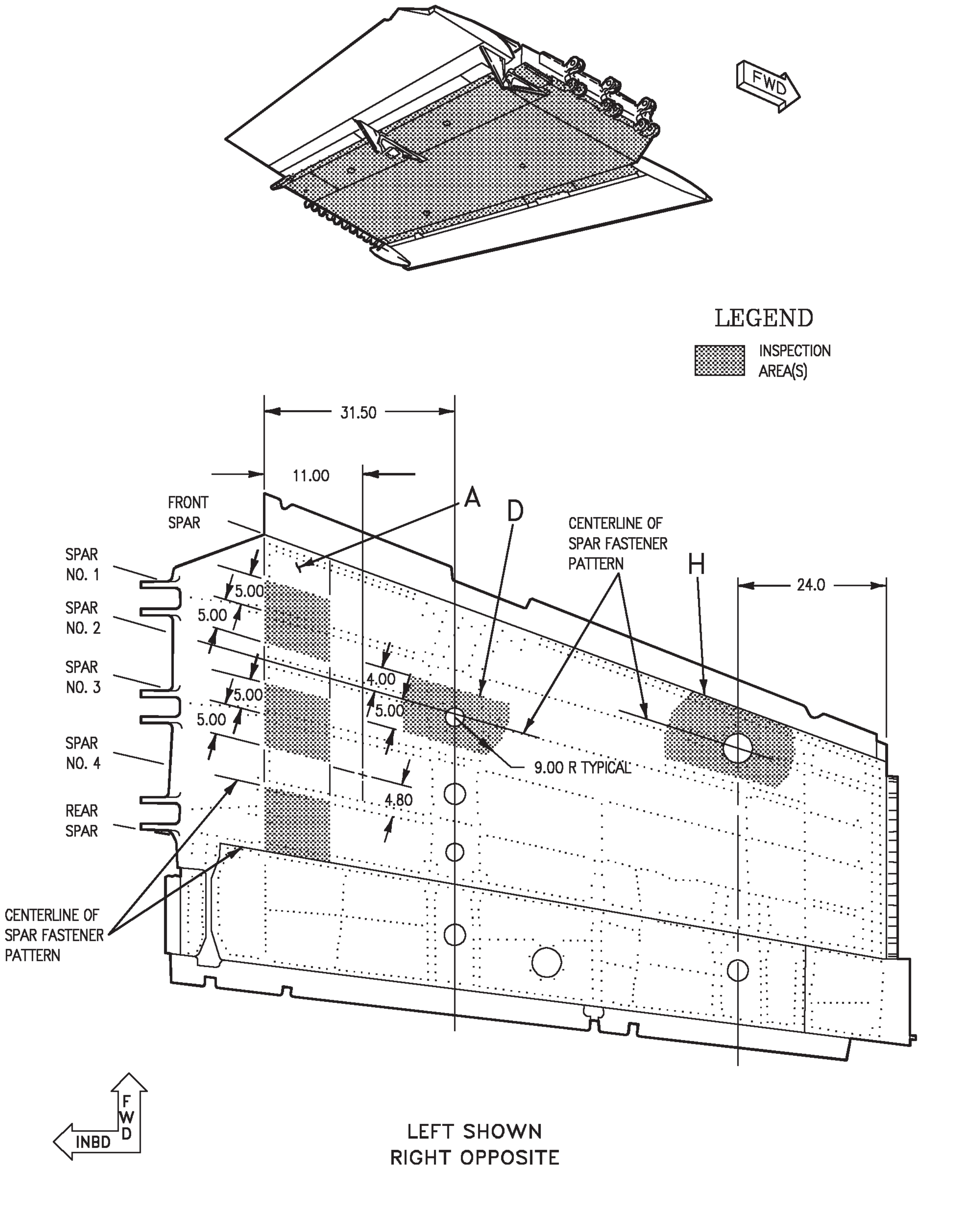
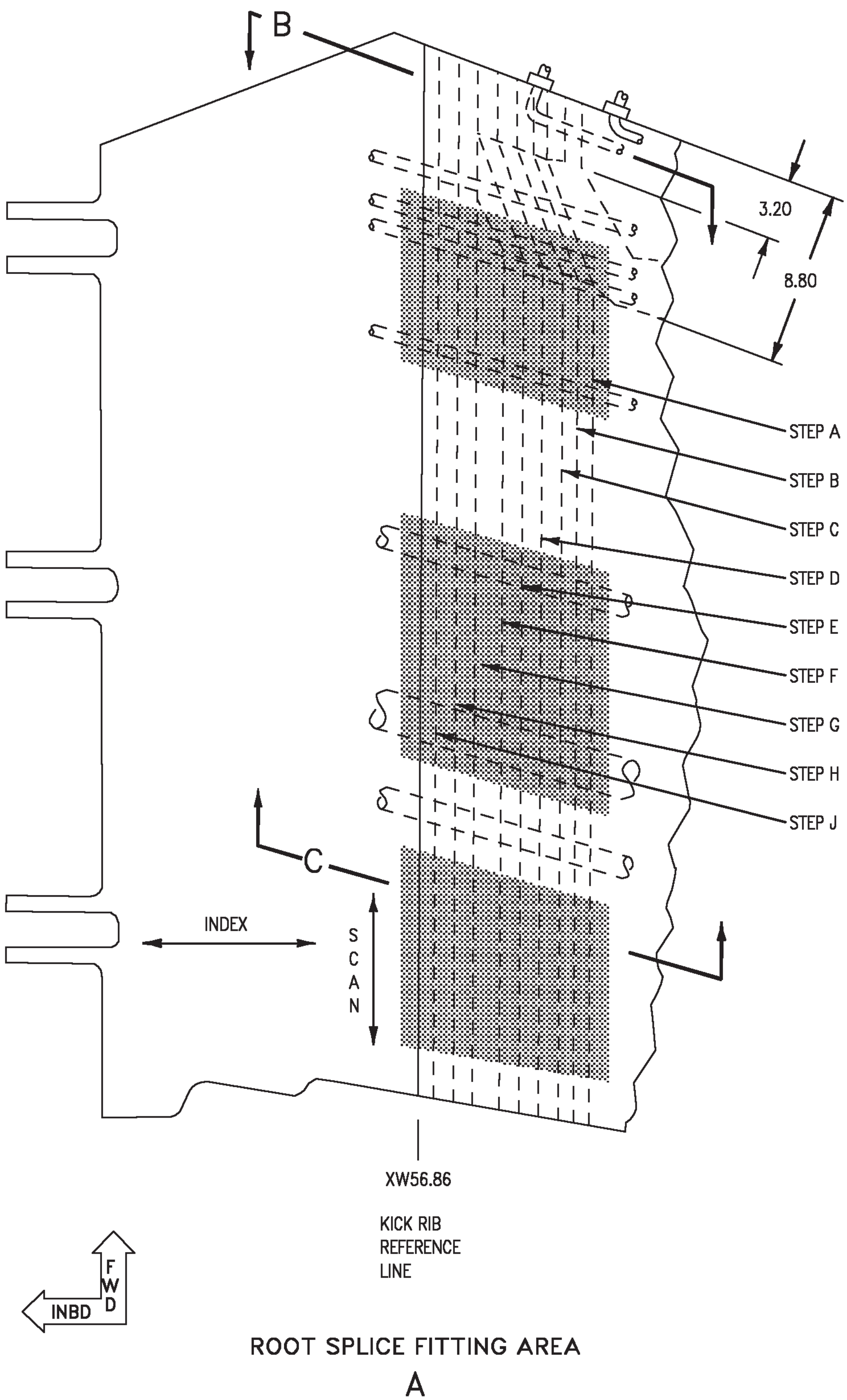
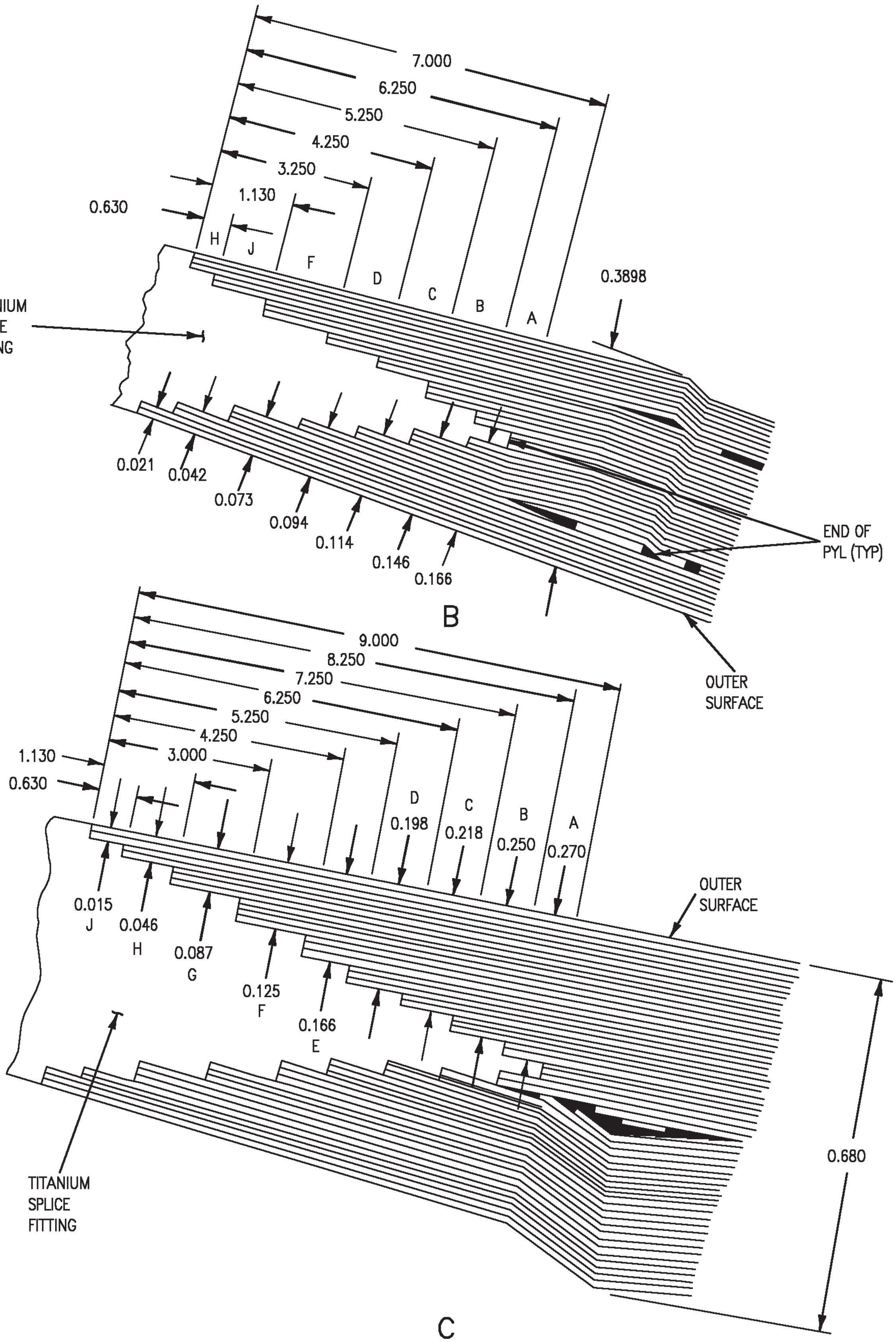


Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 1)



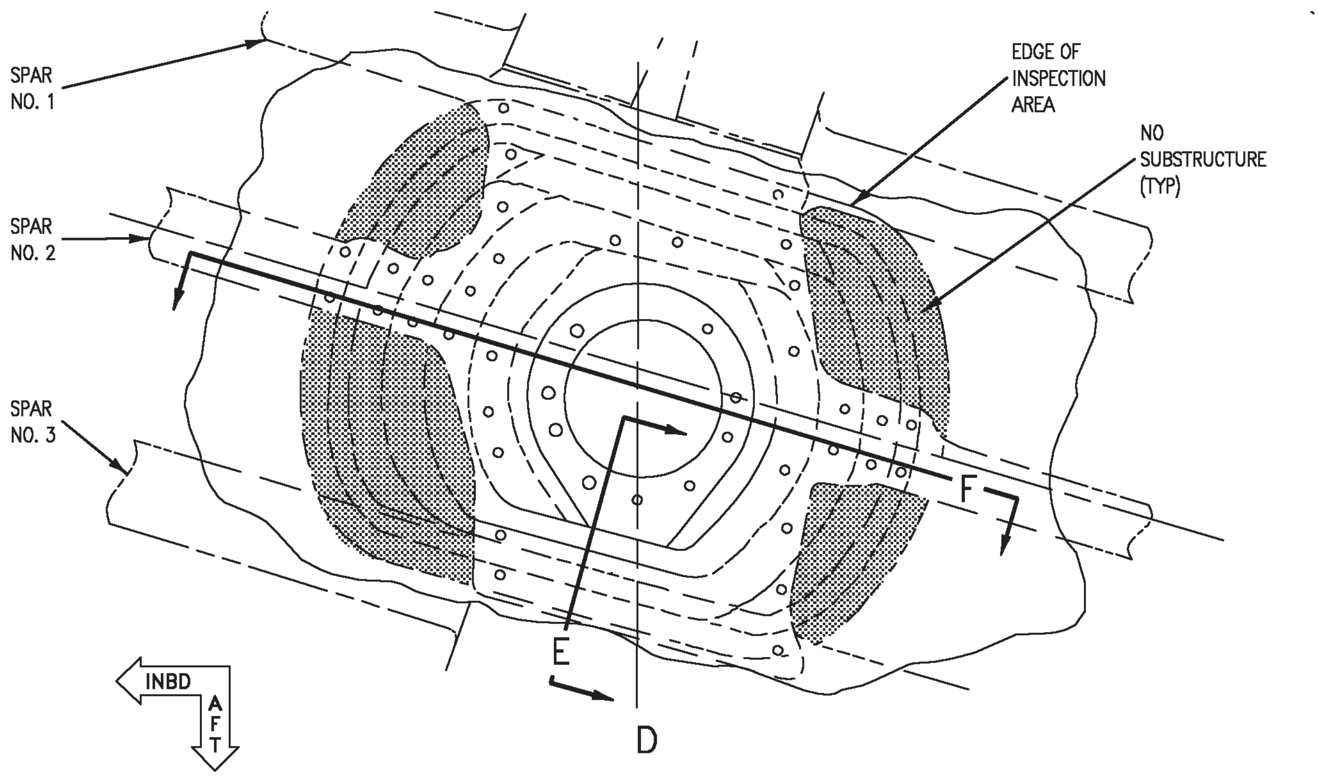
18AC-SRM-30-(122-2)-SCAN

Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 2)

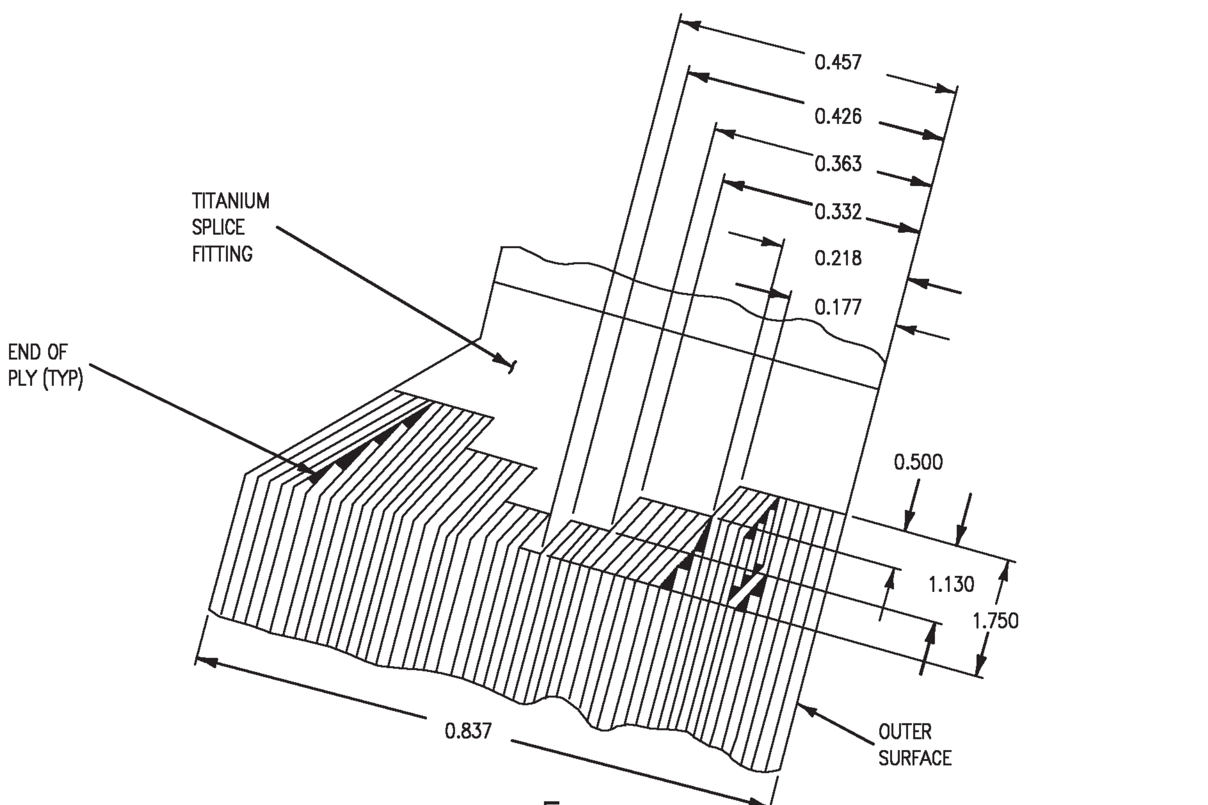


18AC-SRM-30-(122-3)-SCAN

Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 3)



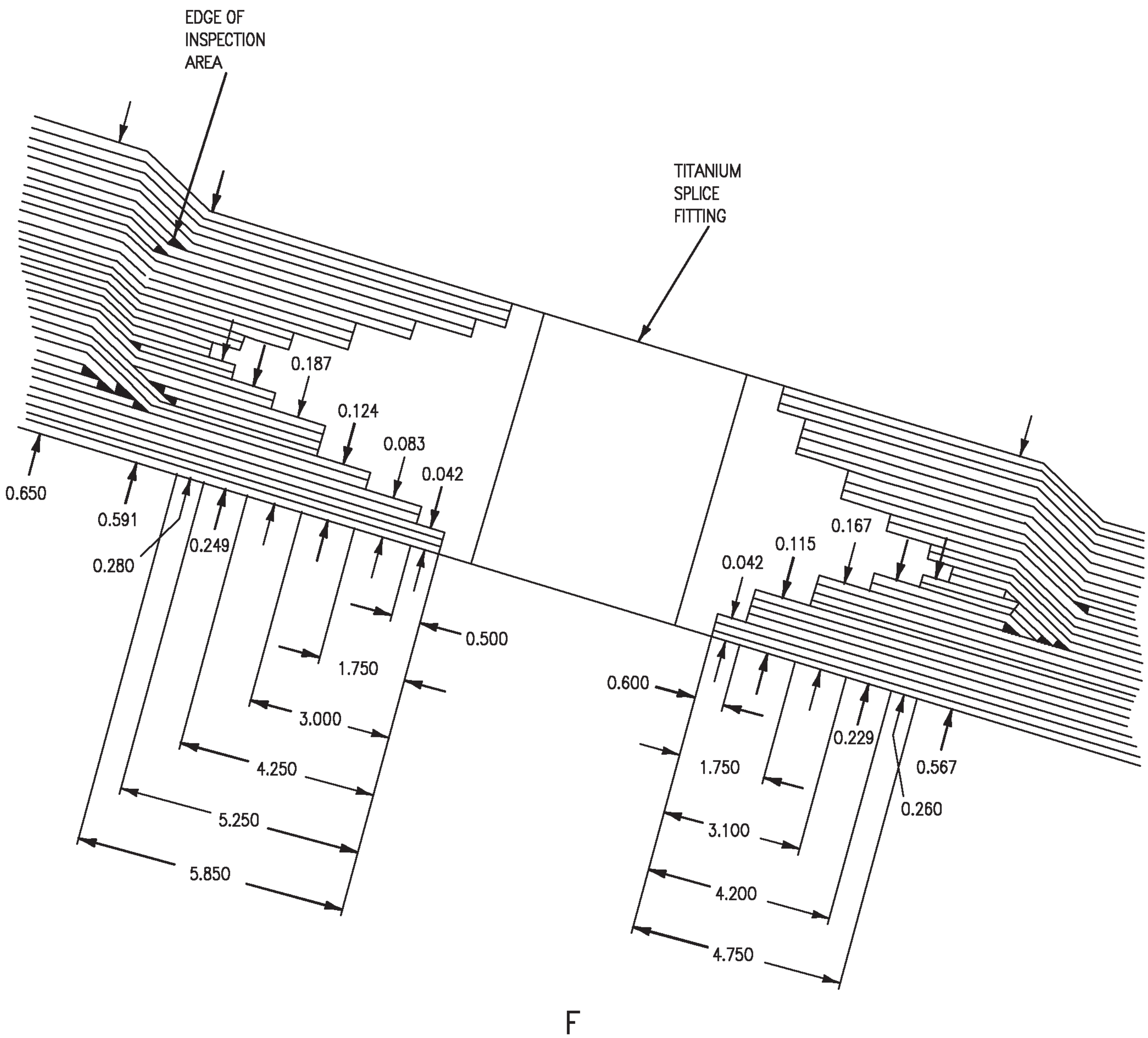
INBOARD PYLON
SPLICE FITTING AREA



E

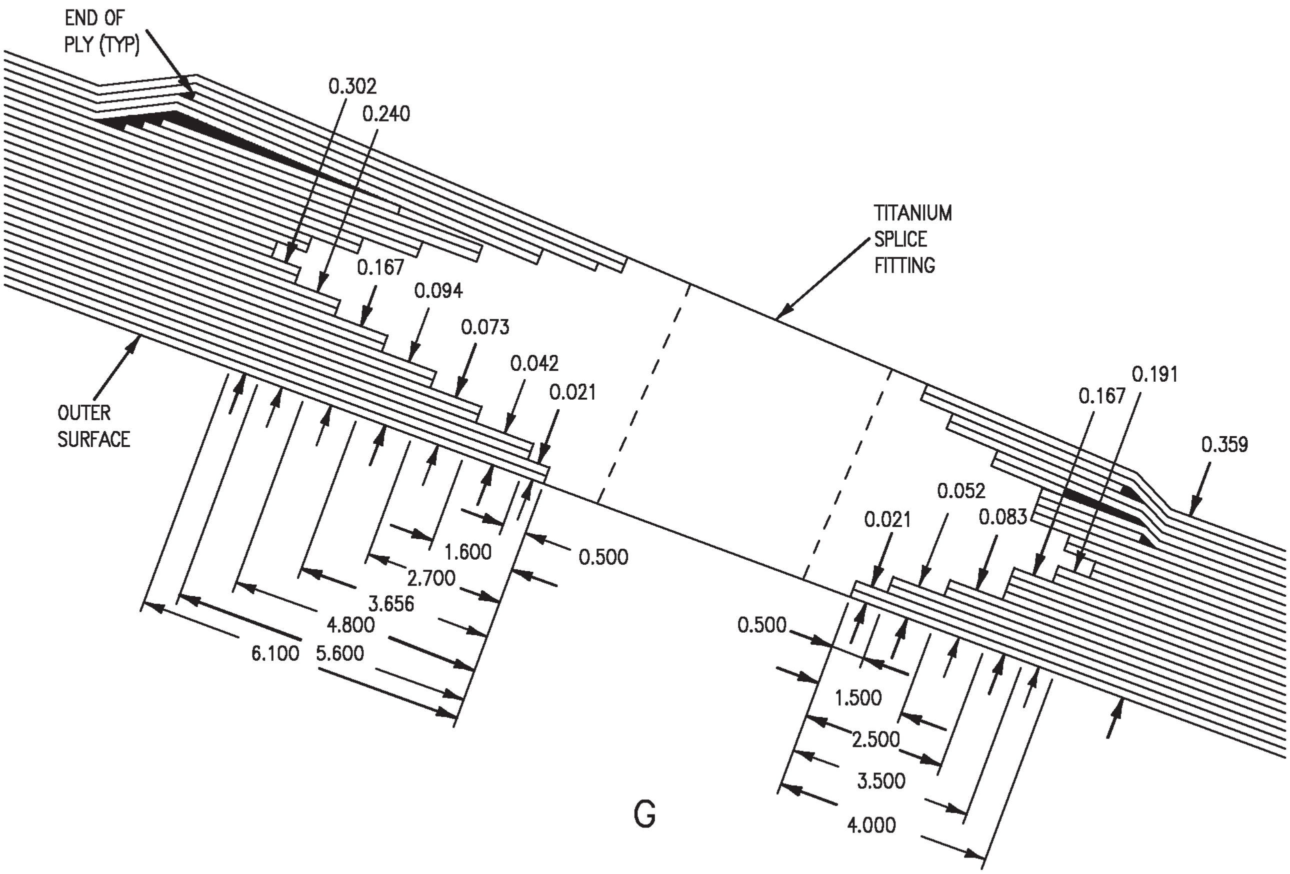
18AC-SRM-30-(122-4)-SCAN

Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 4)

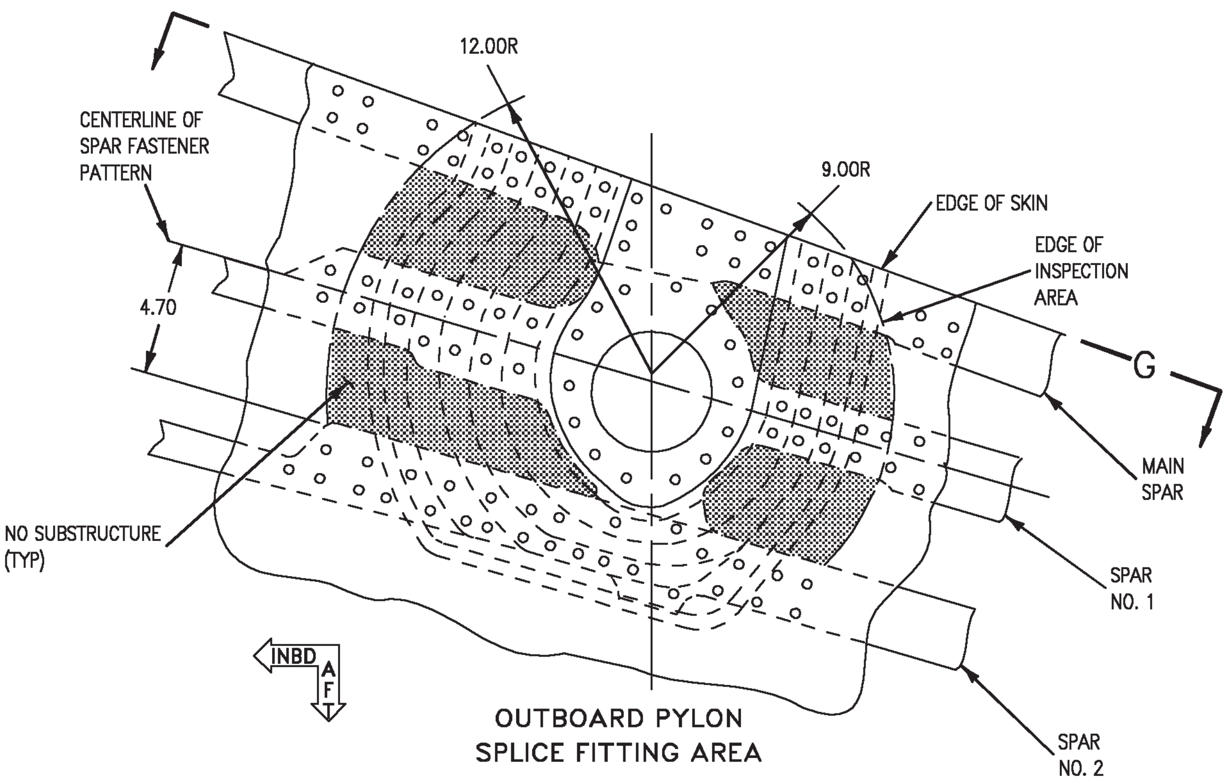


18AC-SRM-30-(122-5)-SCAN

Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 5)



G

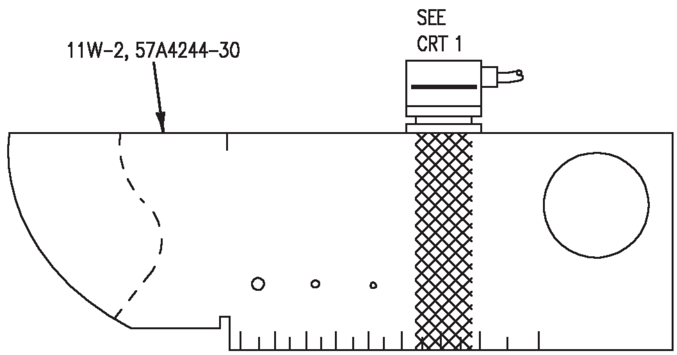


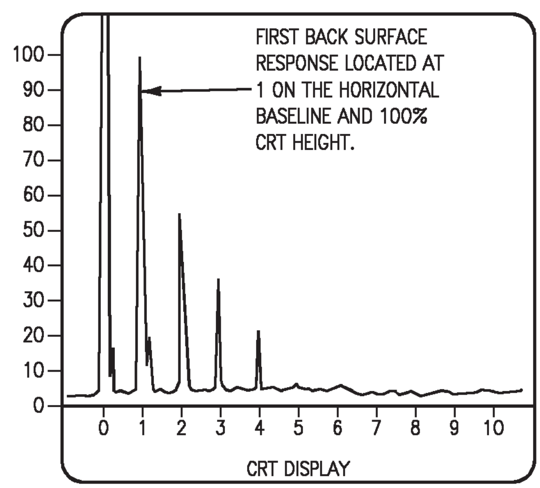
OUTBOARD PYLON
SPLICE FITTING AREA

H

18AC-SRM-30-(122-6)-SCAN

Figure 2. Inner Wing Lower Surface Titanium Splice Fitting Inspection Areas (Sheet 6)





CRT 1

Figure 3. Standardization for Titanium Splice Fitting

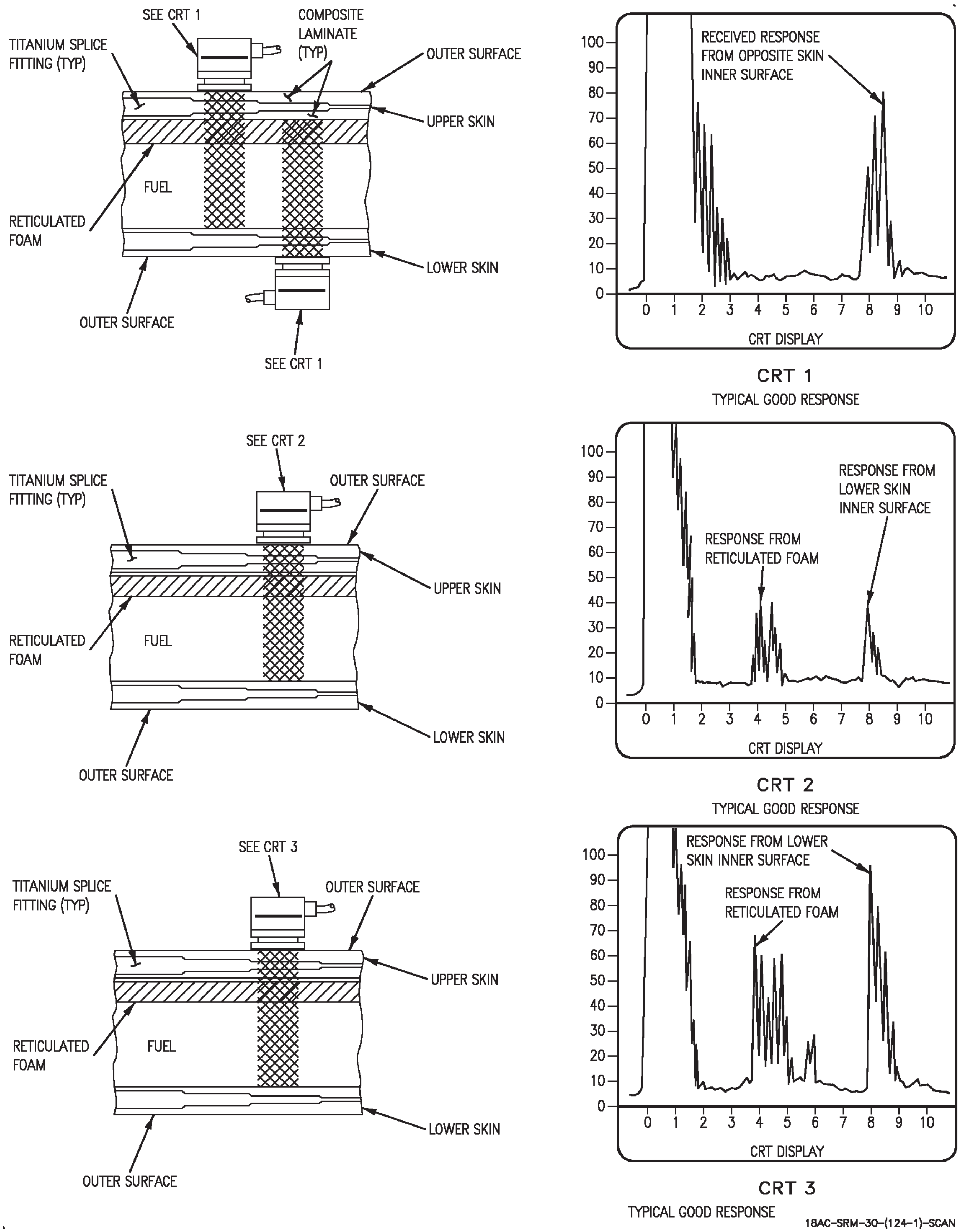


Figure 4. Inspection Responses From Titanium Splice Fitting Areas (Sheet 1)

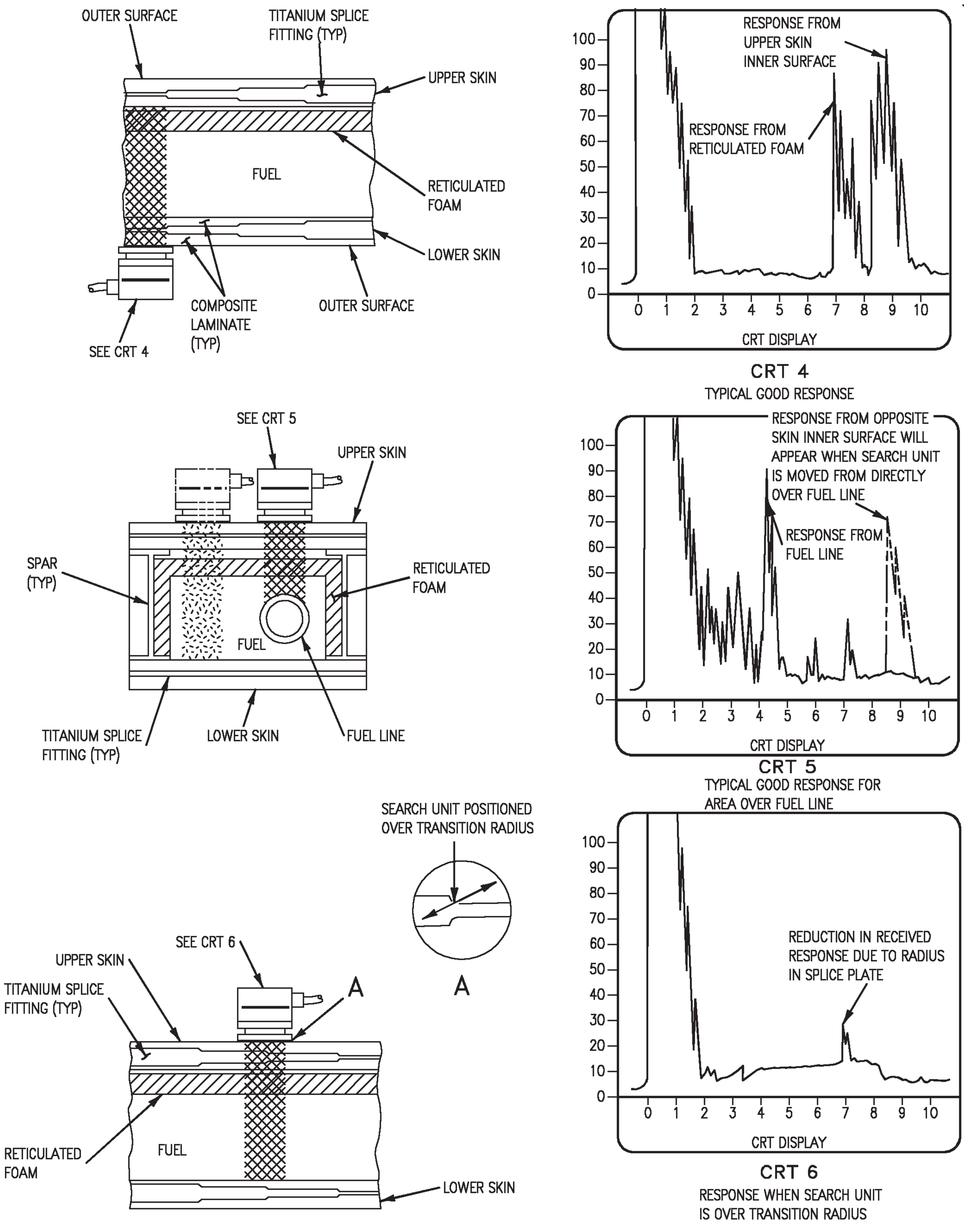
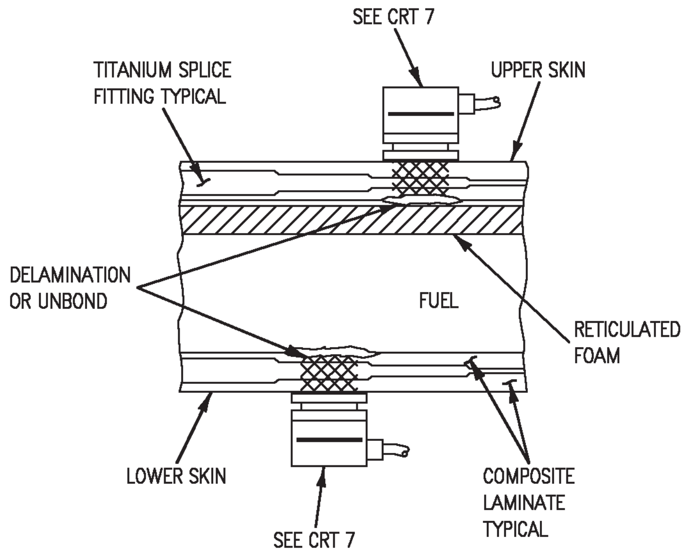
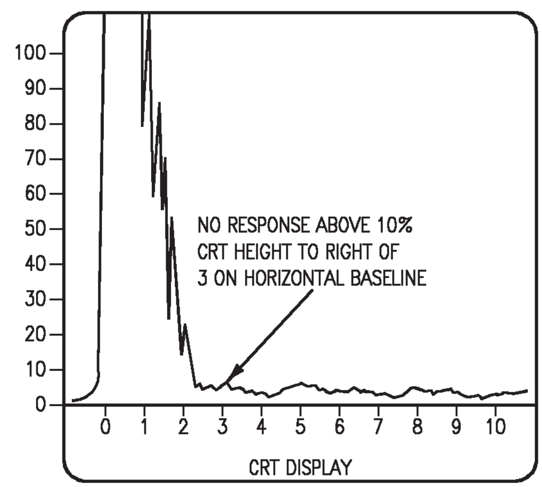


Figure 4. Inspection Responses From Titanium Splice Fitting Areas (Sheet 2)



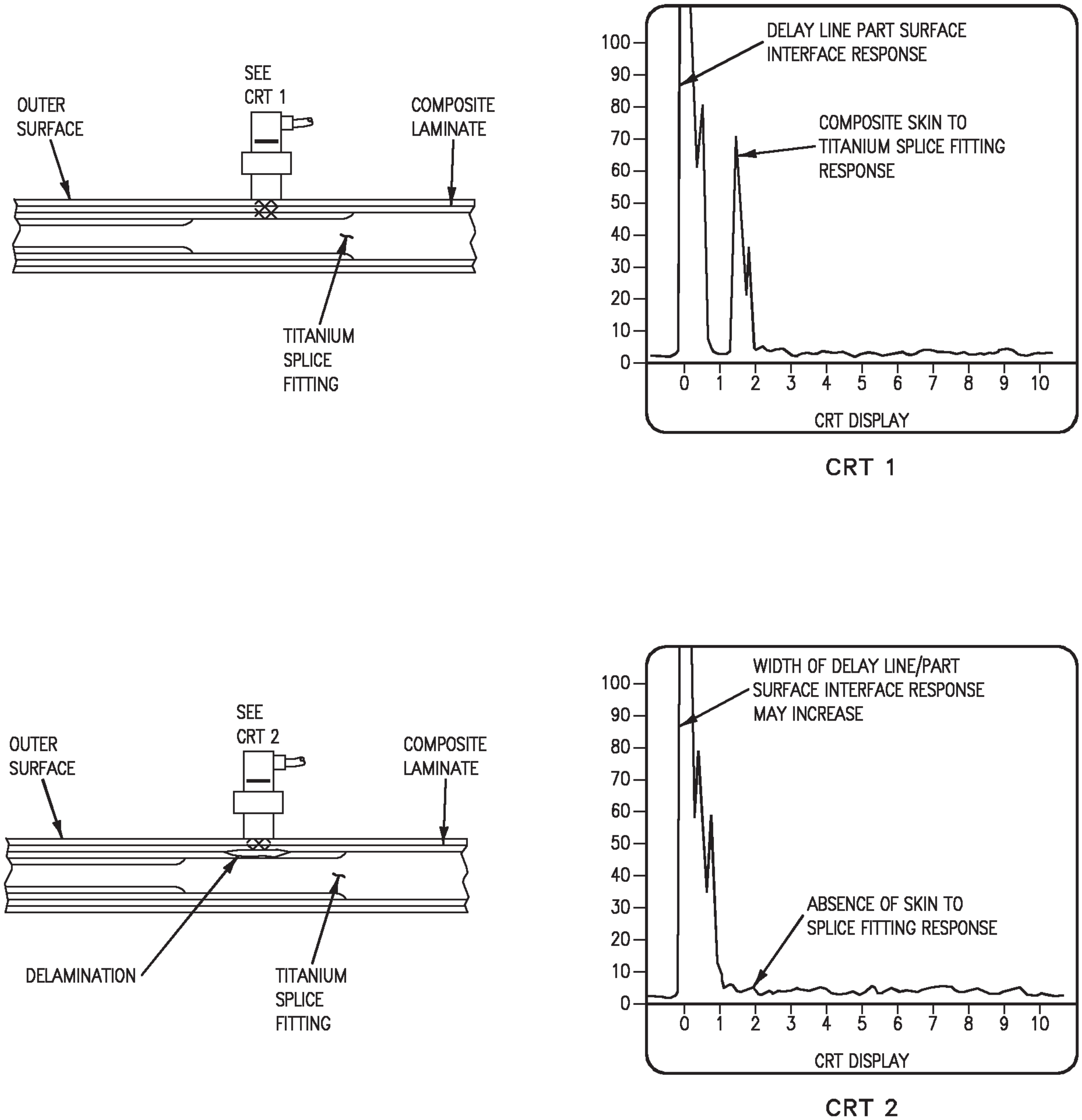


CRT 7

TYPICAL UNBOND OR DELAMINATION RESPONSE

18AC-SRM-30-(124-3)34-SCAN

Figure 4. Inspection Responses From Titanium Splice Fitting Areas (Sheet 3)



18AC-SRM-30-(125-1)-SCAN

Figure 5. Inspection Responses From Skin at Titanium Splice Fitting

INTERMEDIATE AND DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

INNER WING UPPER AND LOWER SURFACES COMPOSITE LAMINATE AND DOOR SILL INSPECTION AREAS

UPPER SKIN PART NO. 74A110600

LOWER SKIN PART NO. 74A110601

Reference Material

Fuel System	A1-F18AC-460-300
Fuel Tank Maintenance Precautions and General Preparations	WP013 00
Fuel System	A1-F18AE-460-300
Fuel Tank Maintenance Precautions and General Preparations	WP011 00
Plane Captain Manual	A1-F18AC-PCM-000
Line Maintenance Procedures	A1-F18AC-LMM-000
Line Maintenance Access Doors	A1-F18AC-LMM-010
Aircraft Corrosion Control	A1-F18AC-SRM-500
Form in Place Sealing	WP010 00
Weapon Control System	A1-F18AC-740-300
AIM-7 Illumination Antenna System	WP021 00
Weapon Control System	A1-F18AE-740-300
AIM-7 Illumination Antenna Program	WP025 00
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Pulse-Echo, Longitudinal Wave, Contact, Without Delay Line, For Composite Laminate Material	WP008 02
Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material	WP008 03
Pulse-Echo, Longitudinal, Contact, Without Delay Line, For Composite Laminate Materials	WP008 11
Pulse-Echo Longitudinal, Contact, With Delay Line, For Composite Laminate Materials	WP008 12

Alphabetical Index

Alphabetical Index (Continued)

Record of Applicable Technical Directives

None

1. **INNER WING UPPER AND LOWER SURFACES.**

2. Inner wing upper and lower surfaces (skins), see figures 1 and 2, are graphite epoxy composite laminate material with titanium splice fittings. Surface finish is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect for delaminations in upper and lower skins. Examples of delaminations that may develop in laminate assembly are contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** Have wing fuel cell defueled and purged per steps below:

a. Defueling (A1-F18AC-PCM-000).

b. Drain residual fuel per substeps below:

(1) Position approved safety container under wing drain valve.

WARNING

To prevent personal injury, do not stand directly under drain valve.

(2) Open drain valve (A1-F18AC-LMM-000).

(3) Close drain valve when residual fuel has been drained (A1-F18AC-LMM-000).

c. Purge (A1-F18AC-460-300, WP013 00 or A1-F18AE-460-300, WP011 00).

7. **Access.**

a. Have doors 76, 77, and 106 removed (A1-F18AC-LMM-010).

b. Have missile illuminator antenna removed from lower fixed trailing edge panel (A1-F18AC-740-300, WP021 00 or A1-F18AE-740-300, WP025 00).

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia., 5 MHz, Contact, Delay Line Search Unit
GD0504	0°, 0.25 Dia., 5 MHz, Contact, Delay Line Search Unit

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.950 Inch
—	Safety Container

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

9. **Preparation of Part.**

a. Have sealant removed from sills of doors 76, 77, and 106 (A1-F18AC-SRM-500, WP010 00).

b. Have sealant removed from sill of missile illuminator antenna (A1-F18AC-SRM-500, WP010 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

c. Clean inspection areas with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection areas are free of contamination or foreign material.

d. Locate and mark inspection areas and boundaries on upper and lower skins as shown in figures 1 and 2.

10. **Equipment Settings/Standardization/Setup For Solid Composite Laminate Areas.** Do equipment standardization/setup (WP008 02) except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

a. Set up for laminates less than 0.450 thick before inspecting laminates less than 0.450 thick (WP008 02).

b. Set up for laminates less than 0.950 thick before inspecting laminates less than 0.950 thick (WP008 02).

c. Make sure trailing edge of initial pulse is located less than 1 large division when 0.100 FBH response is 80 to 90 percent CRT height.

11. **Inspection Procedure for Solid Laminate Areas.** After doing applicable standardization laminates less than 0.450 thick or laminates less than 0.950 thick, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2 (WP008 02) and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thickness are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height.

c. For inspection responses in addition to those described in (WP008 02), see figure 3, this WP.

d. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 03).

12. **Equipment Settings/Standardization/Setup for Door Sill Areas.** Do standardization in same manner as solid laminate areas, setting up for material up to 0.950 thick for upper skin sills, and setting up for material up to 0.450 thick for lower skin door sills.

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

13. **Inspection Procedure for Door Sill Areas.** After doing applicable standardization, 0.450 thick, for lower wing skin door sill 0.950 for upper wing skin door sill, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2 (WP008 02) and as below:

a. Initially position search unit on inspection area where laminate thickness can be measured mechanically.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Scan area to be inspected and occasionally finger damp back surface by placing couplant on end of finger and touching opposite reflected back surface response on CRT will move up and down as it is damped.

c. For inspection responses in addition to those described in (WP008 02), see figure 4, this WP, CRTs 1 and 2 for upper skin and CRT 3 for lower skin.

d. Map and identify flaws located near surface by pulse-echo contact delay line inspection (WP008 03).

e. Do paragraphs 20 and 21.

14. **ULTRASONIC METHOD USING MUX-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia., 5 MHz, Contact, Delay Line Search Unit
GD0504	0°, 0.25 Dia., 5 MHz, Contact, Delay Line Search Unit
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.950 Inch
—	Safety Container

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

15. **Preparation of Part.**

a. Have sealant removed from sills of doors 76, 77, and 106 (A1-F18AC-SRM-500, WP010 00).

b. Have sealant removed from sill of missile illuminator antenna (A1-F18AC-SRM-500, WP010 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

c. Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

d. Locate and mark inspection areas and boundaries on upper and lower skins as shown in figures 1 and 2.

16. **Equipment Settings/Standardization/Setup For Solid Composite Laminate Areas.** Do equipment standardization/setup (WP008 11) except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

a. Set up for laminates less than 0.450 thick before inspecting laminates less than 0.450 thick (WP008 11).

b. Set up for laminates less than 0.950 thick before inspecting laminates less than 0.950 thick (WP008 11).

c. Make sure trailing edge of initial pulse is located less than 1 large division when 0.100 FBH response is 80 to 90 percent CRT height.

17. **Inspection Procedure for Solid Laminate Areas.** After doing applicable standardization laminates less than 0.450 thick or laminates less than 0.950 thick, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2 (WP008 11) and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thickness are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height.

c. For inspection responses in addition to those described in (WP008 11), see figure 3, this WP.

d. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 12).

18. **Equipment Settings/Standardization/Setup for Door Sill Areas.** Do standardization in same manner as solid laminate areas, setting up for material up to 0.950 thick for upper skin sills, and setting up for material up to 0.450 thick for lower skin sills.

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electronic systems and stores (A1-F18AC-PCM-000).

19. **Inspection Procedure for Door Sill Areas.** After doing applicable standardization, 0.450 thick, for lower wing skin door sill 0.950 for upper wing skin door sill, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2 (WP008 11) and as below:

a. Initially position search unit on inspection area where laminate thickness can be measured mechanically.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Scan area to be inspected and occasionally finger damp back surface by placing couplant on end of finger and touching opposite reflected back surface response on CRT will move up and down as it is damped.

c. For inspection responses in addition to those described in (WP008 11), see figure 4, this WP, CRTs 1 and 2 for upper skin and CRT 3 for lower skin.

d. Map and identify flaws located near surface by pulse-echo contact delay line inspection (WP008 12).

20. **POST INSPECTION CLEANING AND CORROSION CONTROL.** After recording any defects, clean inspection marks and couplant from stabilator.

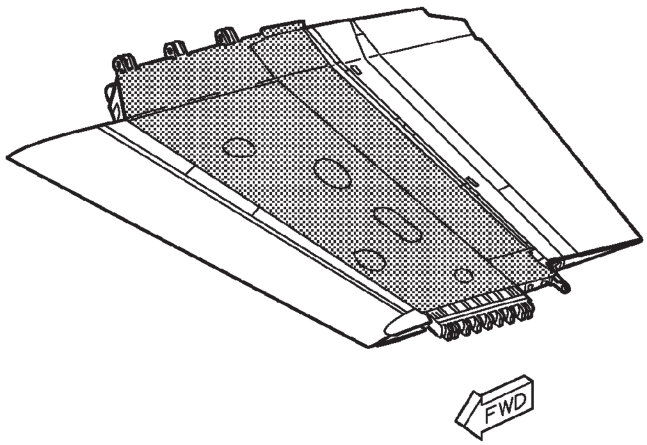
21. **SYSTEM SECURING.**

a. Have form in place seals applied for Doors 76, 77, and 106 (A1-F18AC-SRM-500, WP010 00).

b. Have Doors 76, 77, and 106 installed (A1-F18AC-LMM-010).

c. Have form in place seal applied for missile illuminator antenna (A1-F18AC-SRM-500, WP010 00).

d. Have missile illuminator antenna installed (A1-F18AC-740-300, WP021 00 or A1-F18AE-740-300, WP025 00).



LEGEND

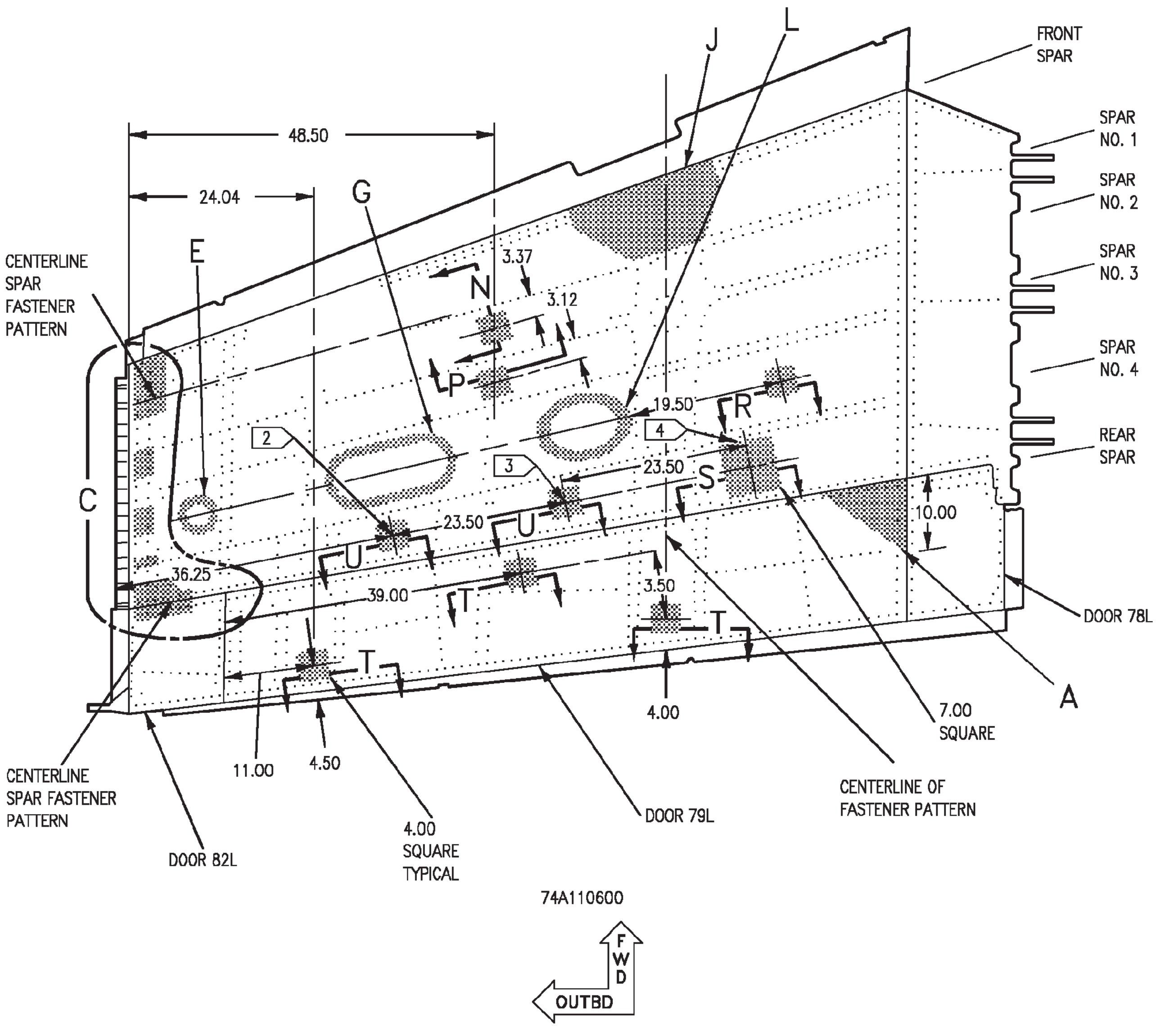
INSPECTION AREAS

1. MEASUREMENTS FOR FOLLOWING NOTES ARE AT RIGHT ANGLES TO NO. 4 AND REAR SPARS.

2 LOCATED 3.1 AFT OF NO. 4 SPAR AND 3.1 FWD OF REAR SPAR.

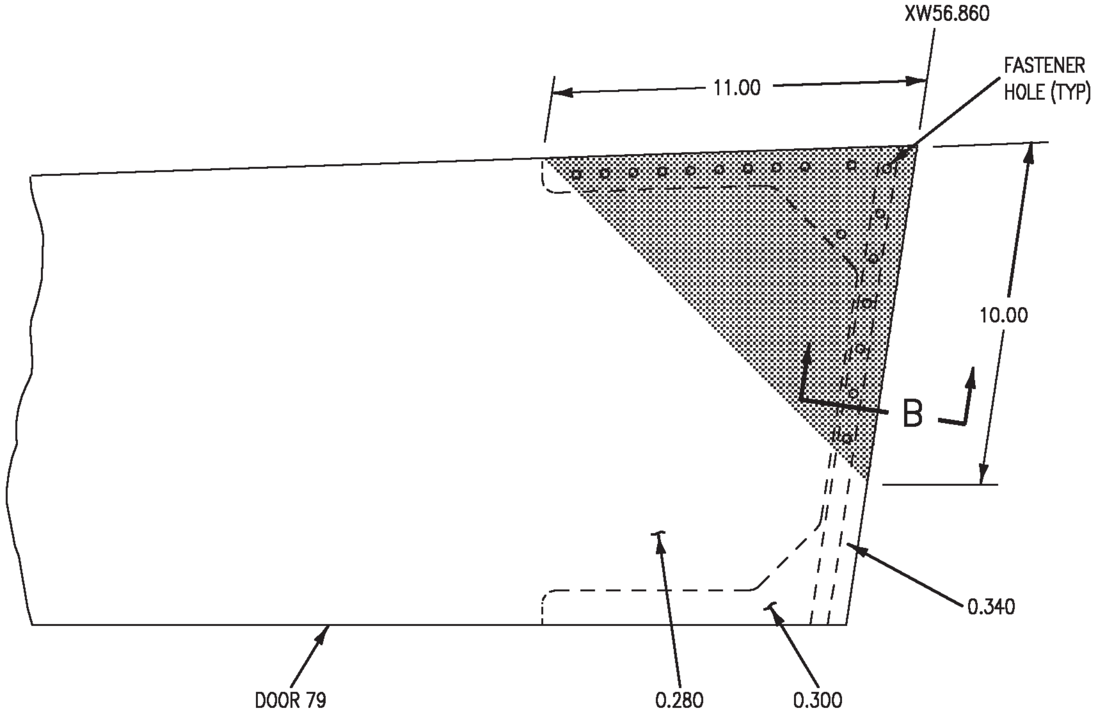
3 LOCATED 3.6 AFT OF NO. 4 SPAR AND 3.6 FWD OF REAR SPAR.

4 LOCATED 4.2 AFT OF NO. 4 SPAR AND 4.2 FWD OF REAR SPAR.



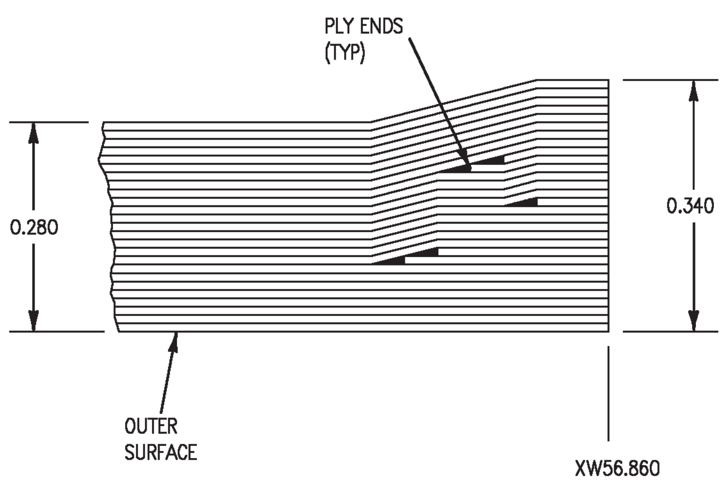
18AC-SRM-30-(126-1)34-SCAN

Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 1)



A

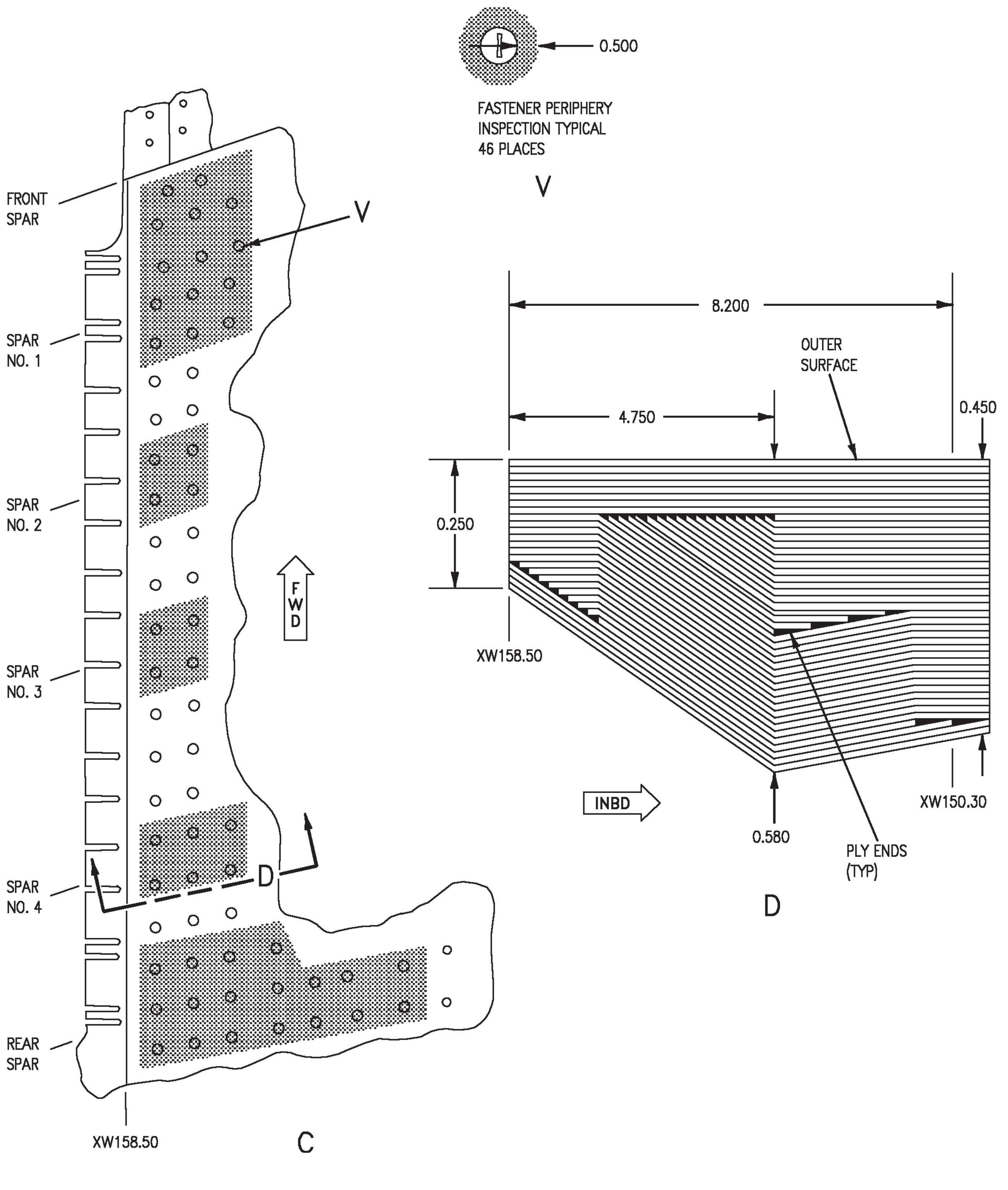
UPPER WING FIXED
TRAILING EDGE PANEL



B

18AC-SRM-30-(126-2)-SCAN

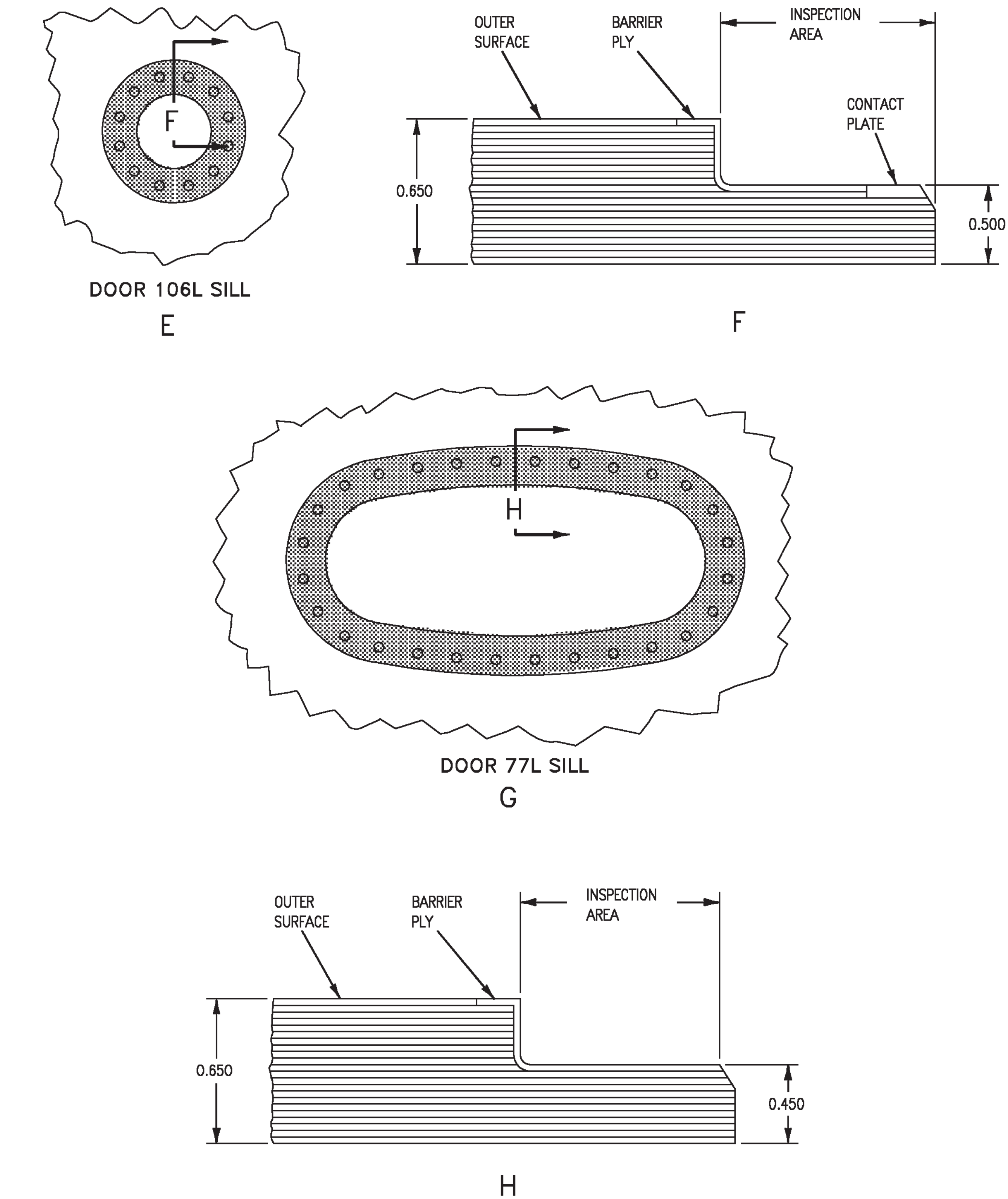
Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 2)



WING FOLD RIB AREA,
TORQUE BOX SKIN

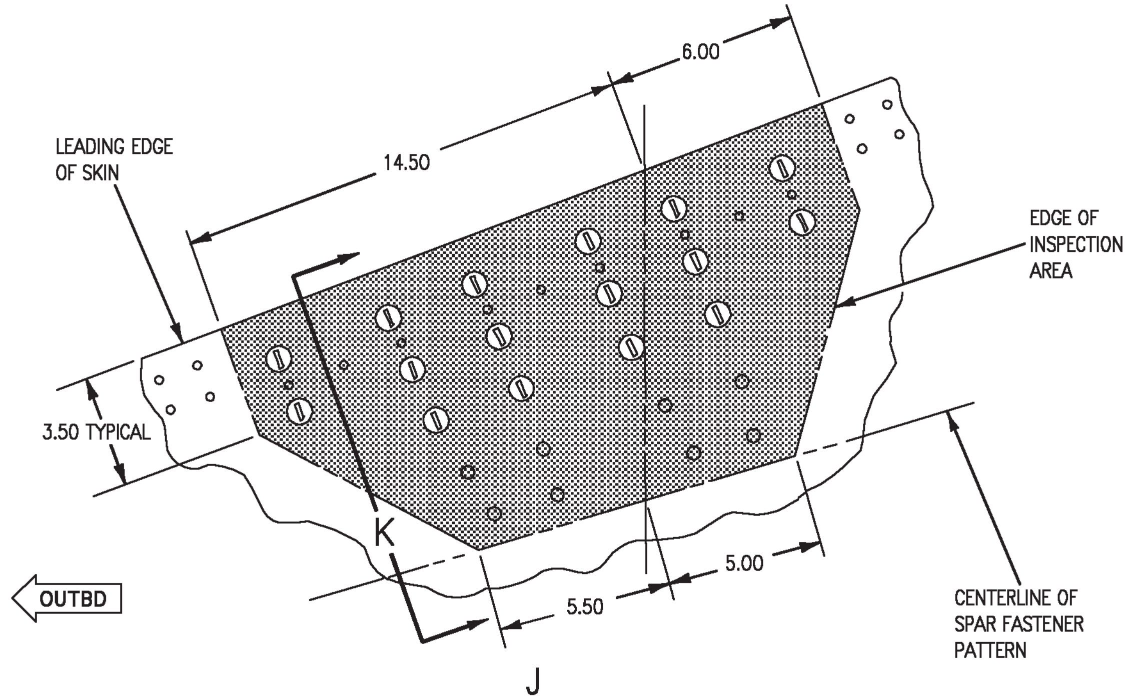
18AC-SRM-30-(126-3)34-SCAN

Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 3)

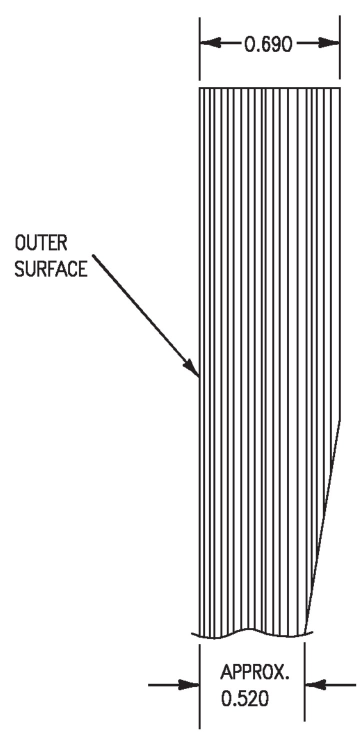


18AC-SRM-30-(126-4)-SCAN

Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 4)



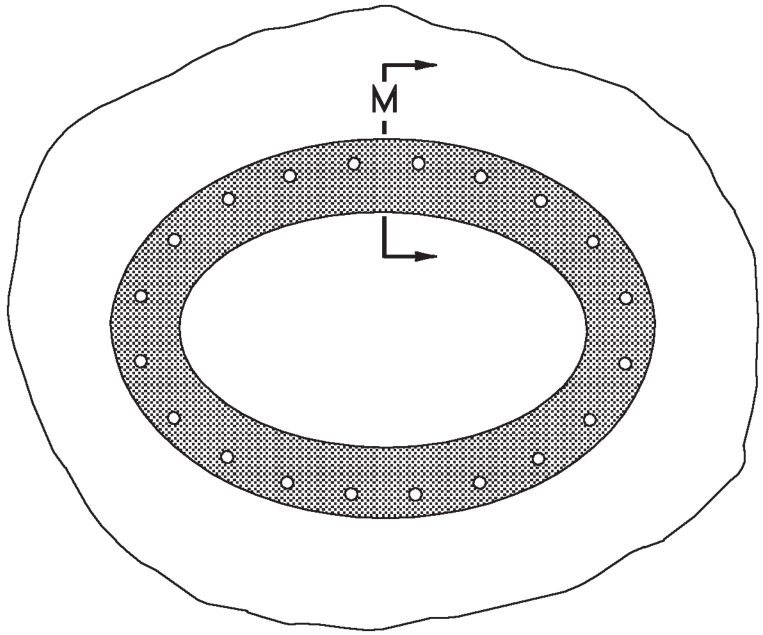
LEADING EDGE FLAP DRIVE AREA



K

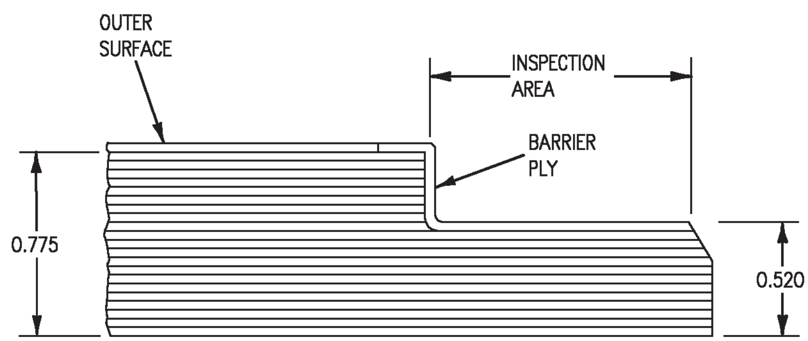
18AC-SRM-30-(126-5)34-SCAN

Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 5)



L

DOOR 76L SILL



M

18AC-SRM-30-(126-6)-SCAN

Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 6)

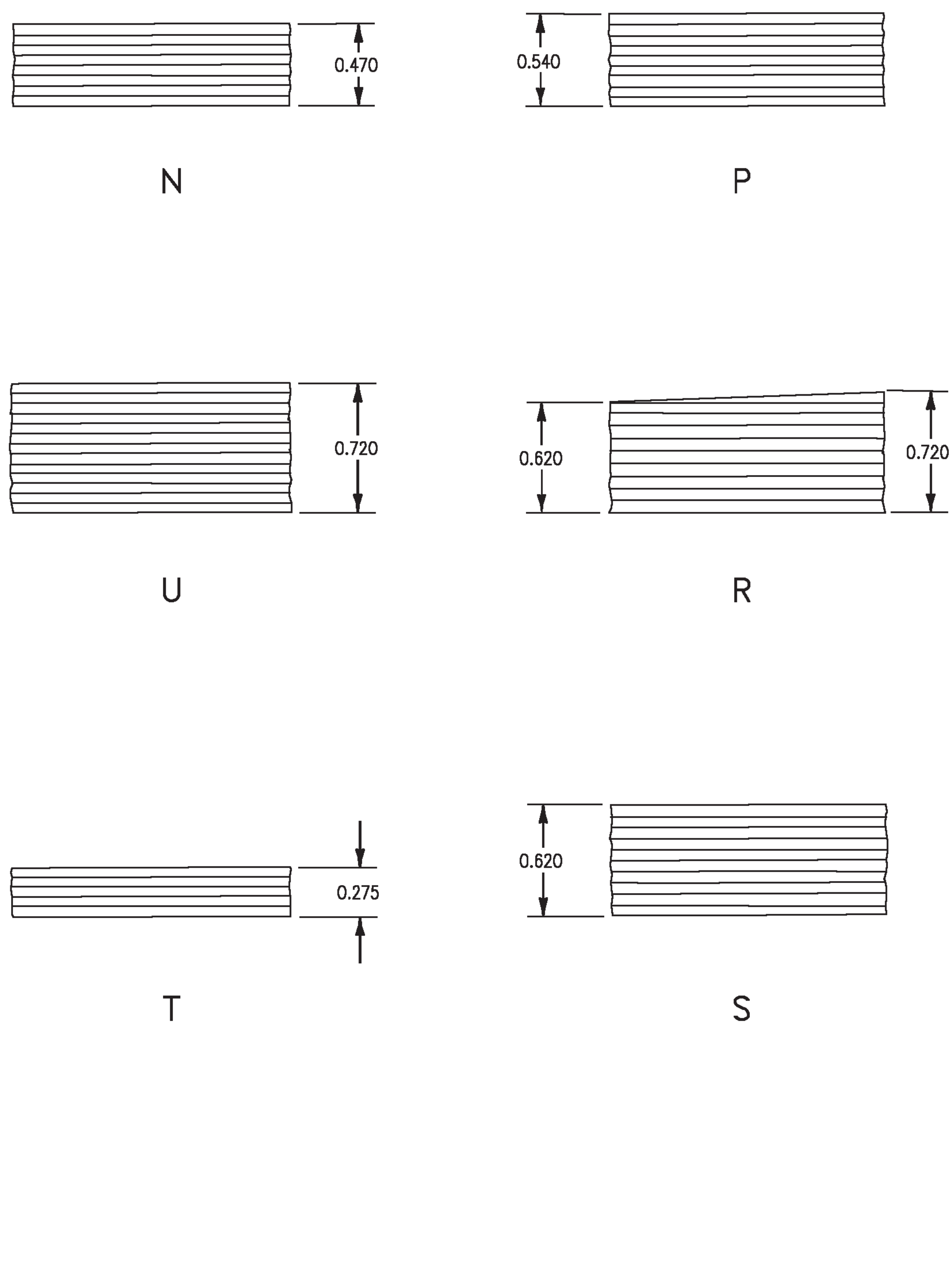
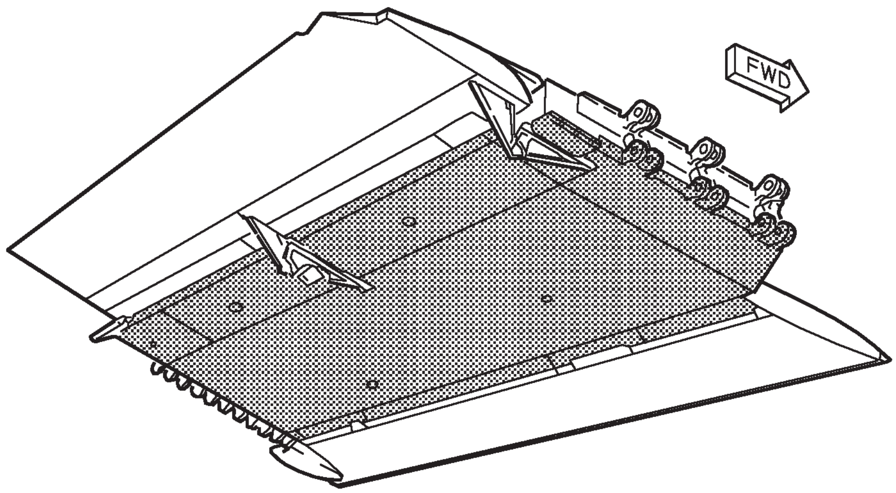
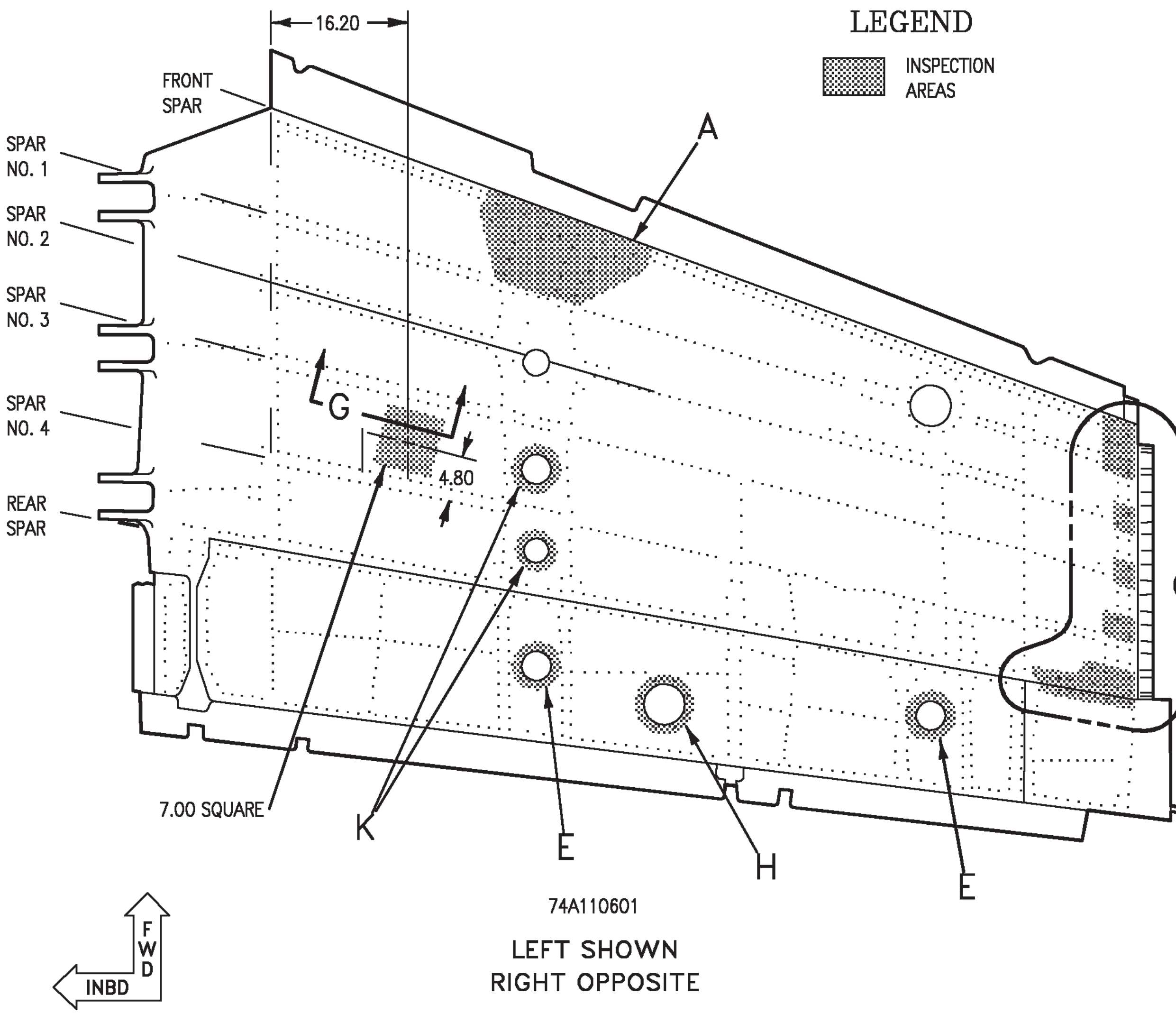


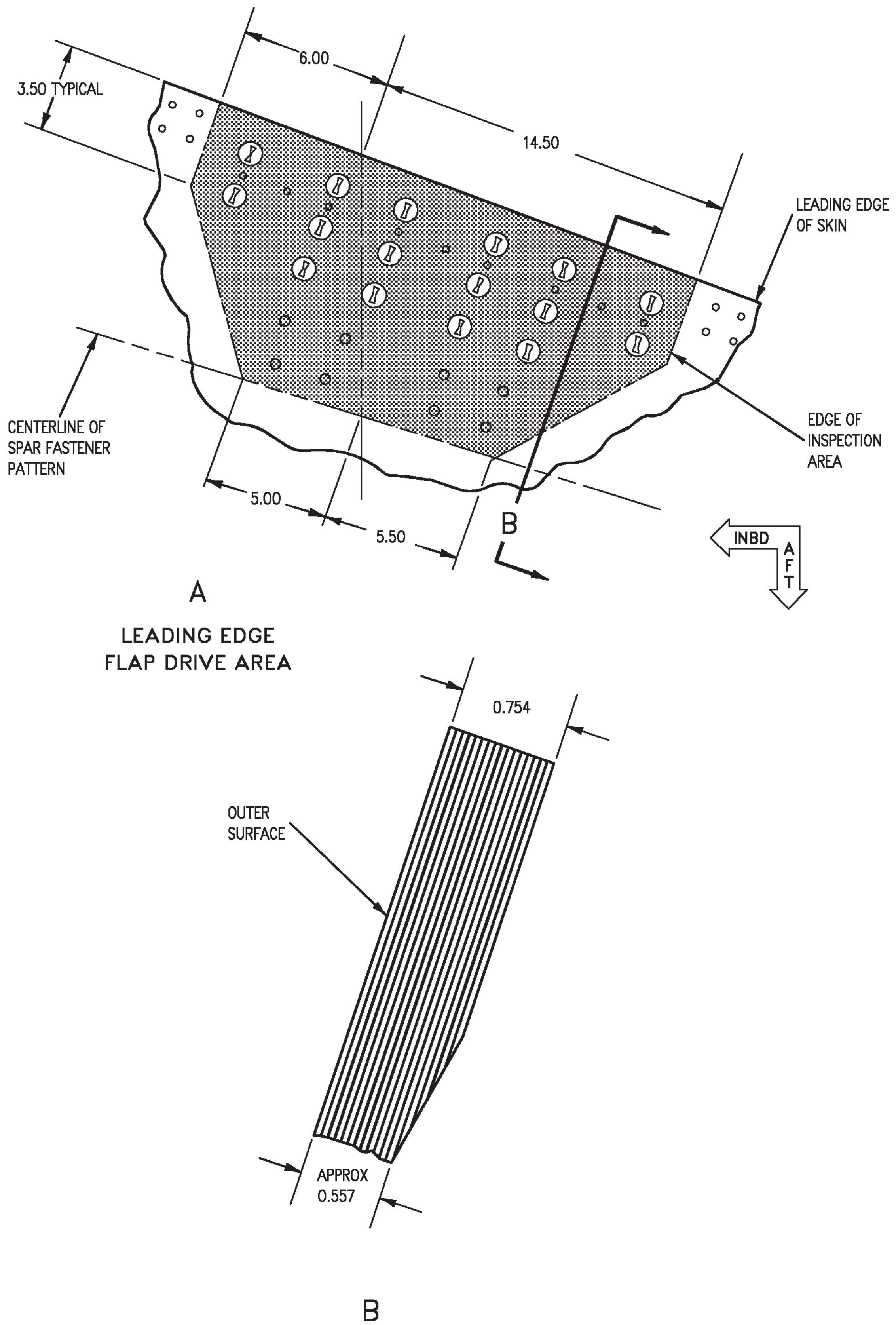
Figure 1. Inner Wing Upper Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 7)





18AC-SRM-30-(127-1)34-SCAN

Figure 2. Inner Wing Lower Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 1)



18AC-SRM-30-(127-2)34-SCAN

Figure 2. Inner Wing Lower Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 2)

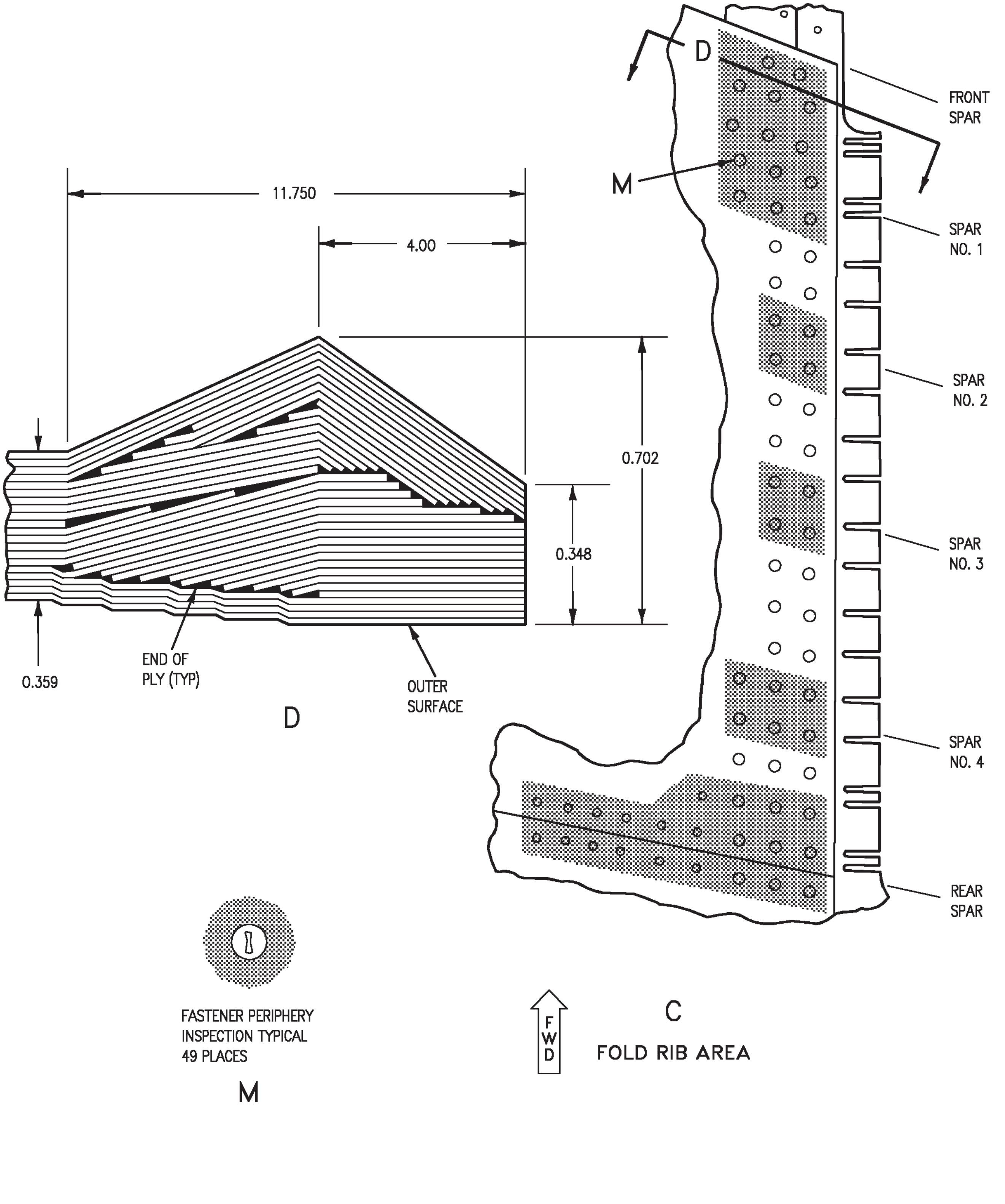
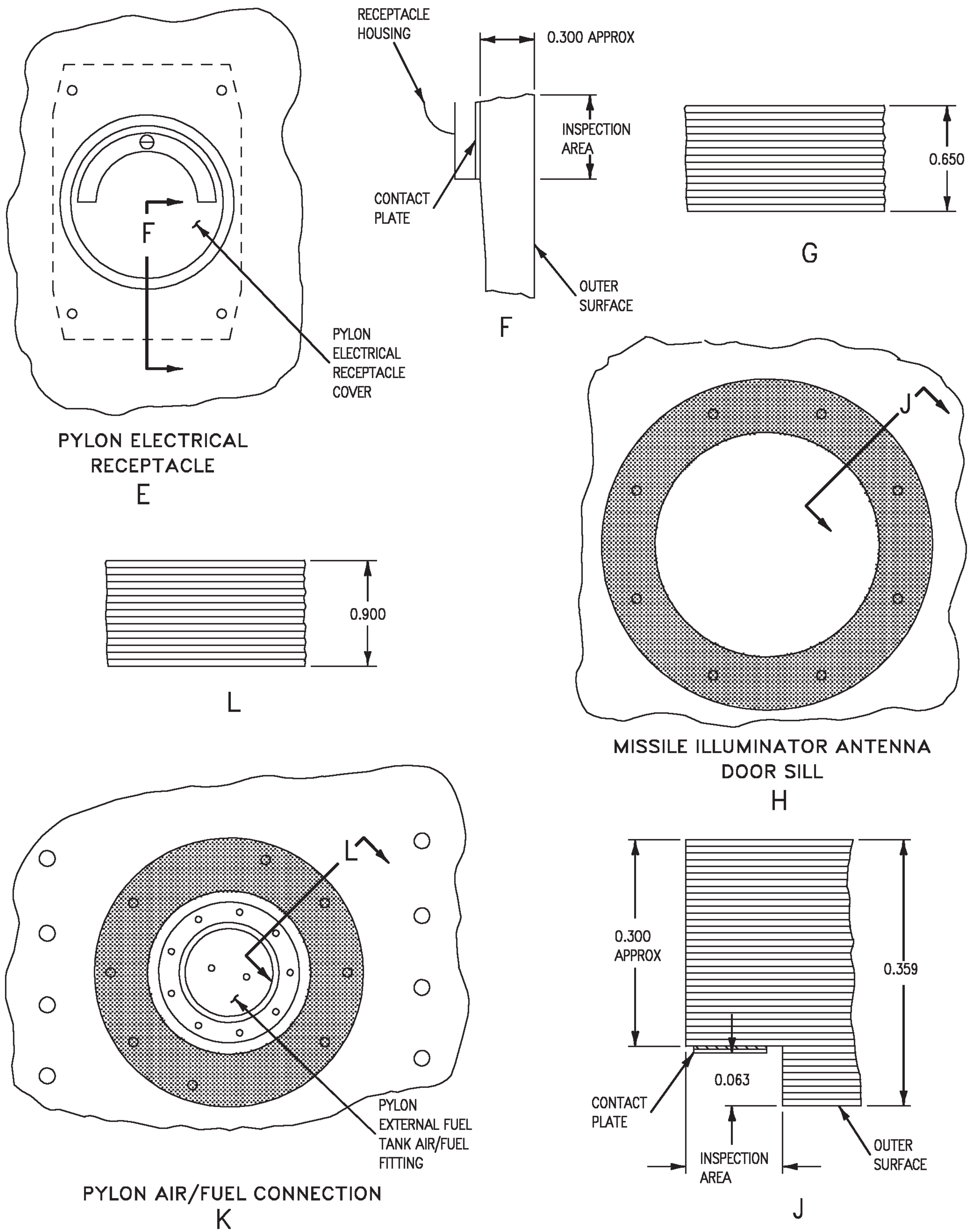


Figure 2. Inner Wing Lower Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 3)



18AC-SRM-30-(127-4)34-SCAN

Figure 2. Inner Wing Lower Surface Solid Composite Laminate and Door Sill Inspection Areas (Sheet 4)

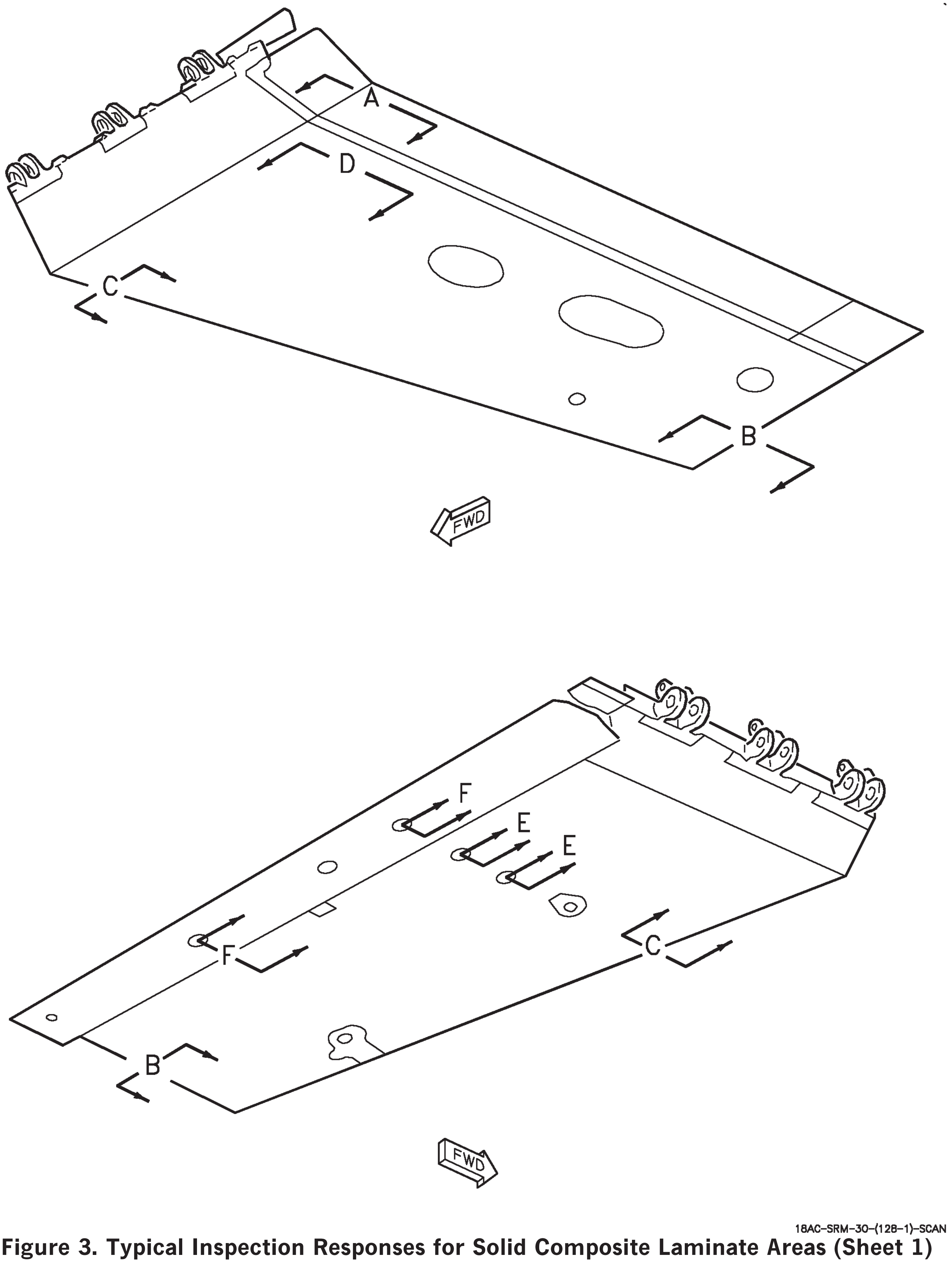


Figure 3. Typical Inspection Responses for Solid Composite Laminate Areas (Sheet 1)

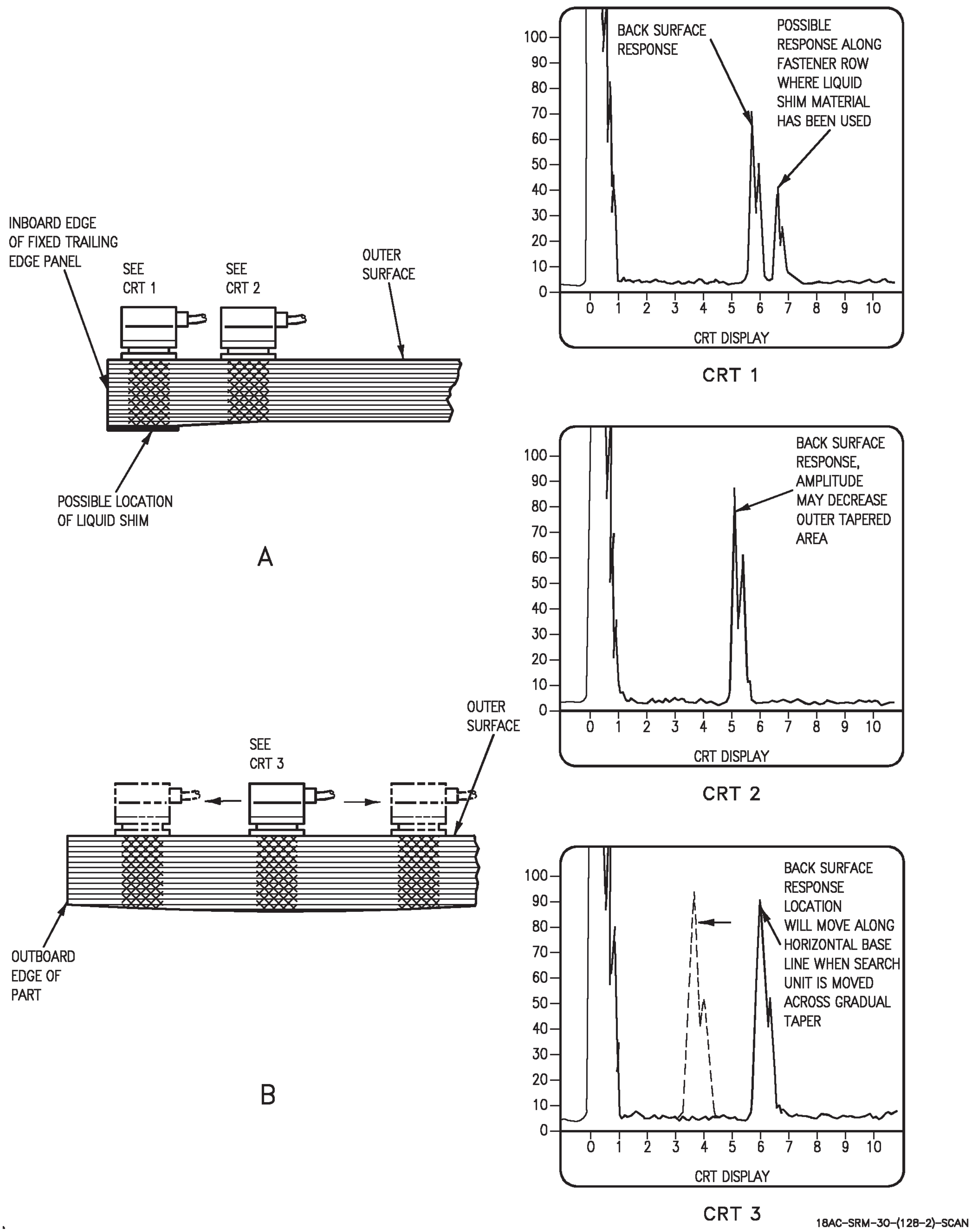
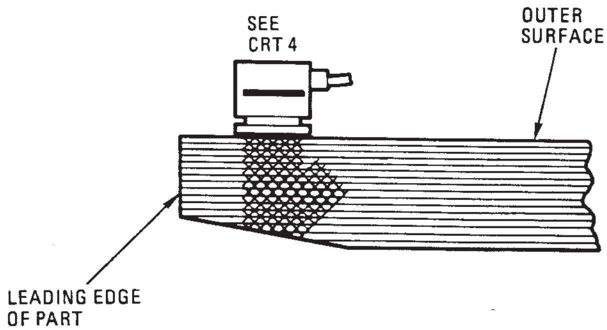
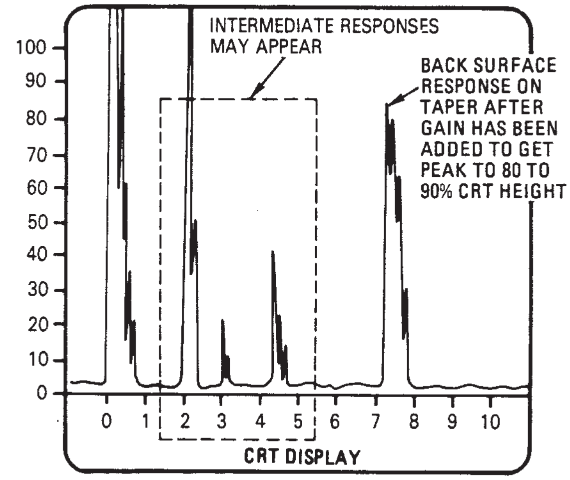


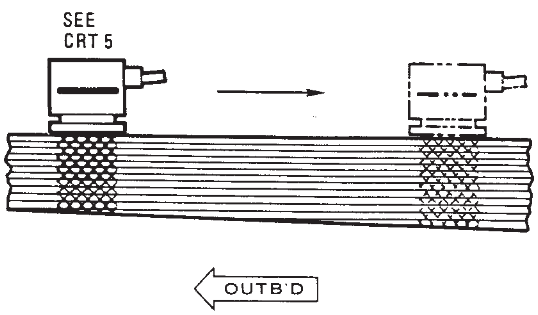
Figure 3. Typical Inspection Responses for Solid Composite Laminate Areas (Sheet 2)



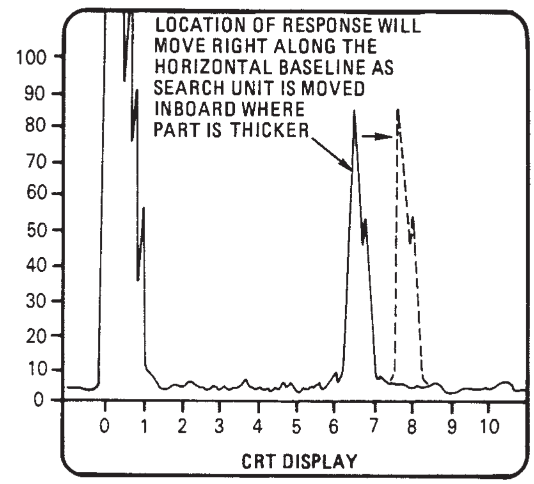
C



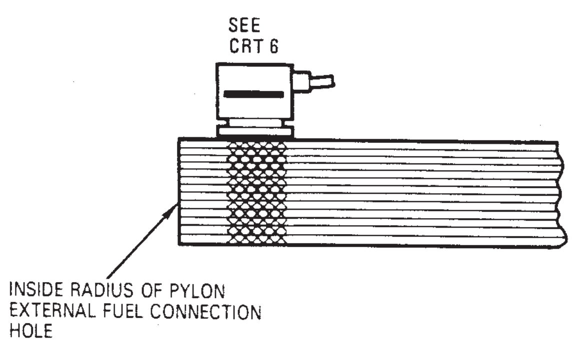
CRT 4



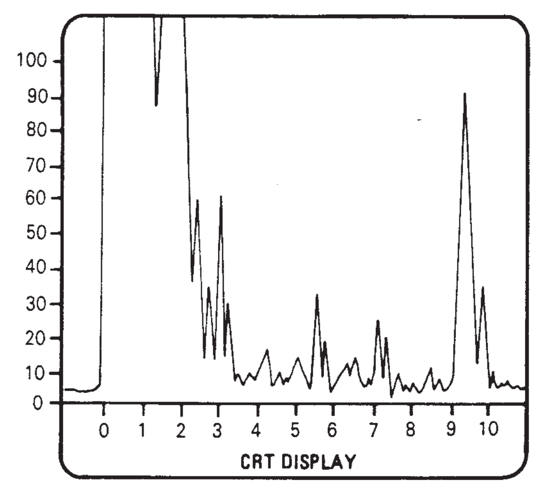
D



CRT 5



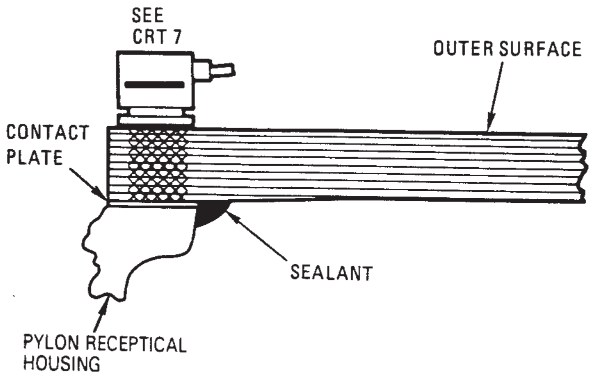
E



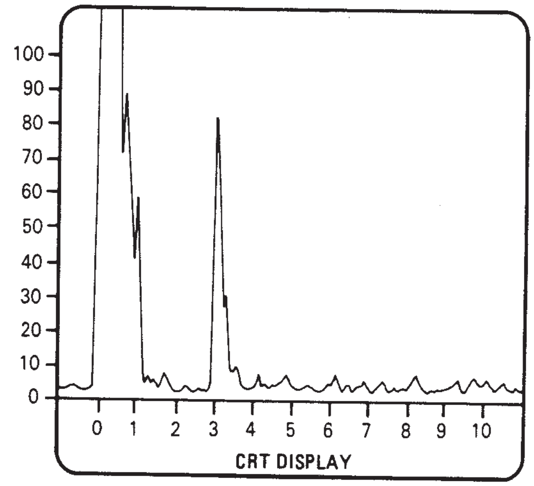
CRT 6

(U/G)
18AC-SRM-30-(128-3)

Figure 3. Typical Inspection Responses for Solid Composite Laminate Areas (Sheet 3)



F



CRT 7

(U/G)
18AC-SRM-30-(128-4)

Figure 3. Typical Inspection Responses for Solid Composite Laminate Areas (Sheet 4)

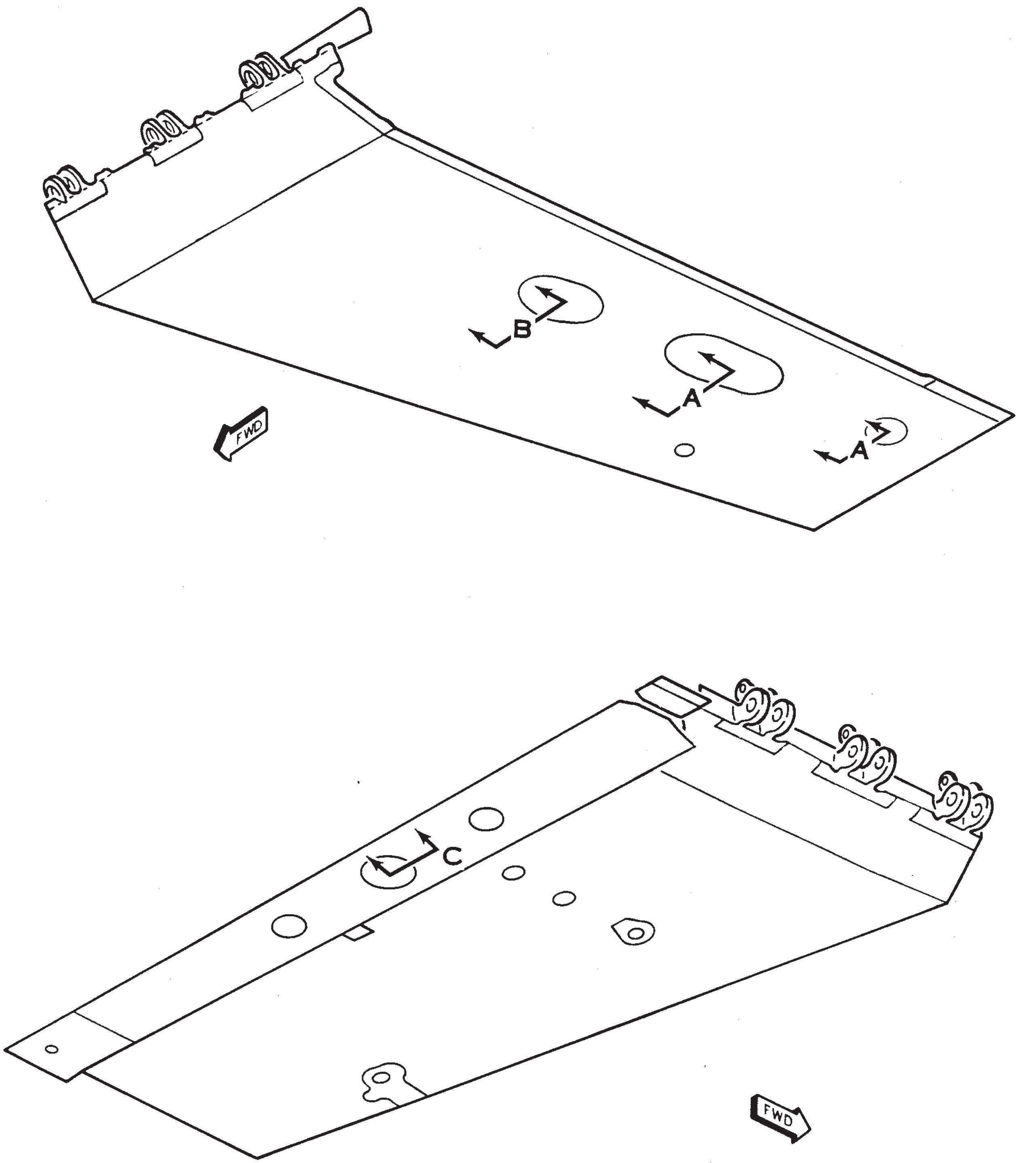
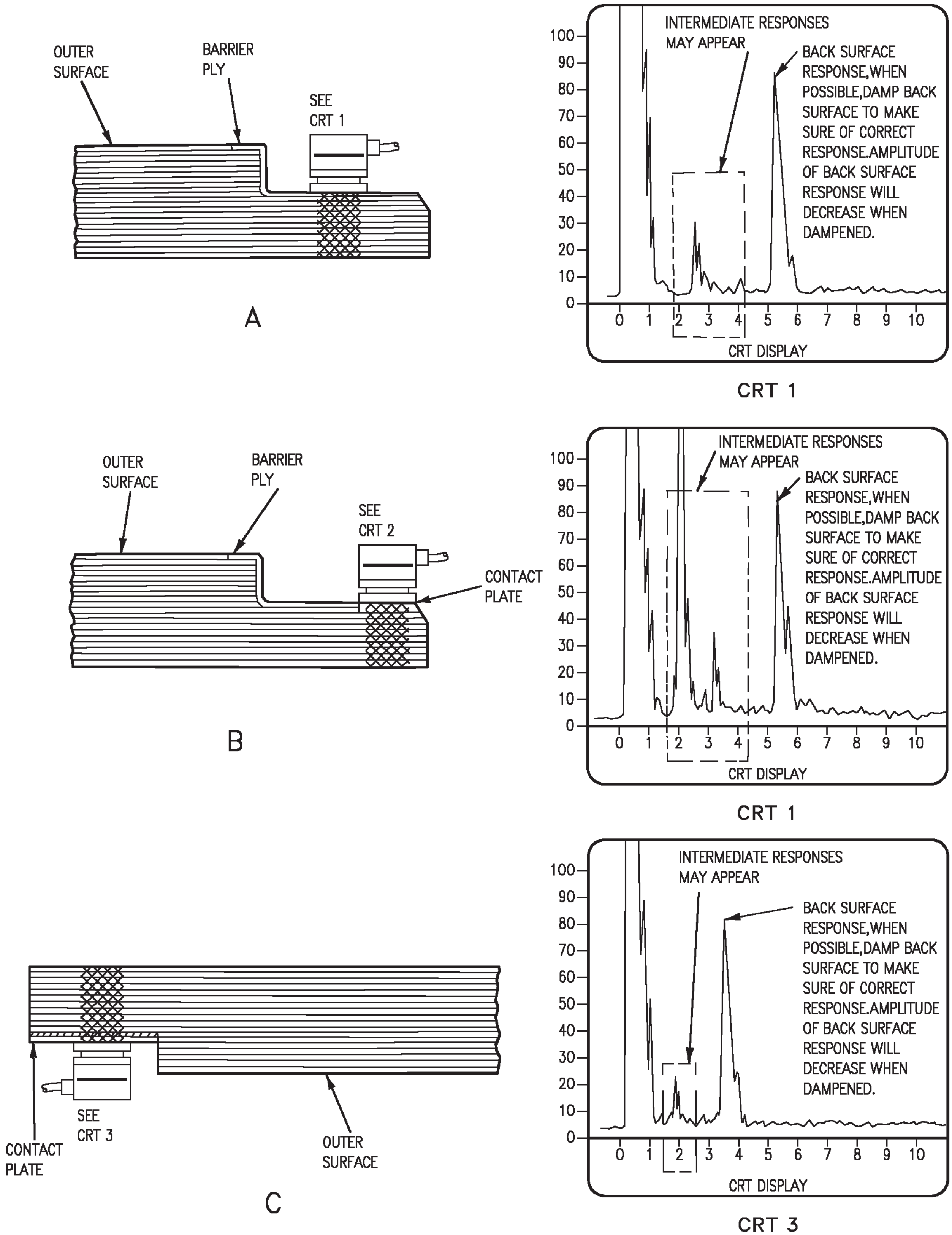
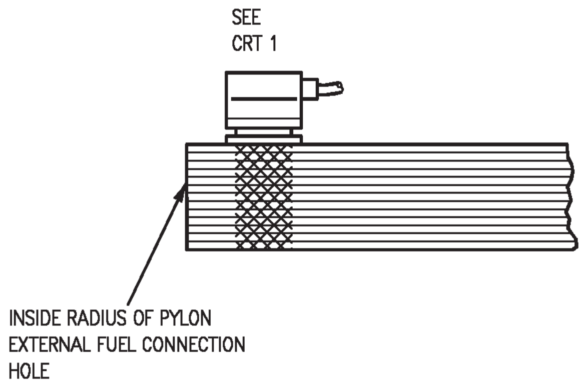


Figure 4. Typical Inspection Responses for Door Sill Areas (Sheet 1)

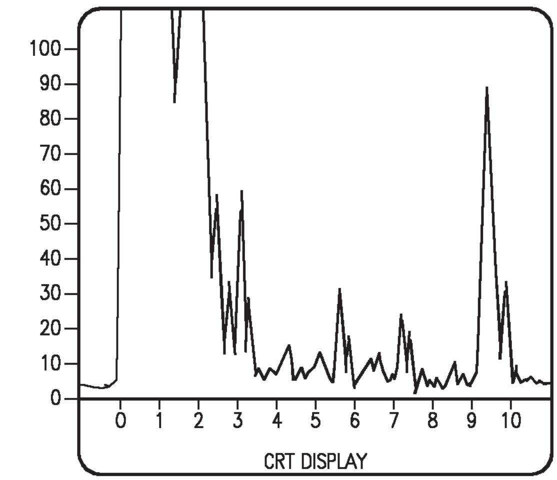


18AC-SRM-30-(129-2)-SCAN

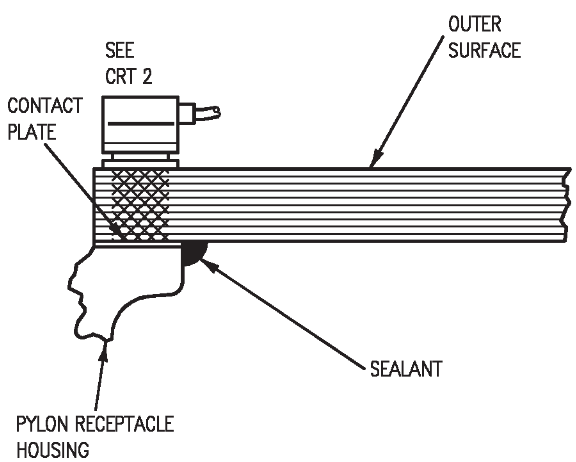
Figure 4. Typical Inspection Responses for Door Sill Areas (Sheet 2)



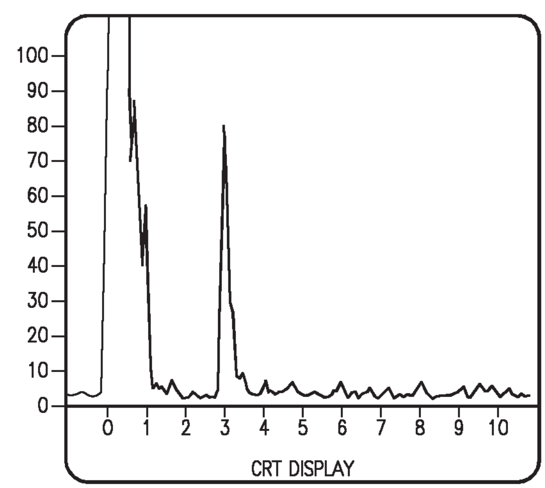
PYLON RECEPTACLE
HOUSING



CRT 1



PYLON RECEPTACLE
HOUSING



CRT 2

18AC-SRM-30-(447-1)32-SCAN

Figure 5. Typical Inspection Response for Solid Composite Laminate Areas

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

OUTER WING TORQUE BOX SKIN

DELAMINATIONS

UPPER SKIN PART NO. 74A150600

LOWER SKIN PART NO. 74A150601

This WP supersedes WP024 00, dated 15 March 1993.

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Pulse-Echo, Longitudinal Wave Contact Without Delay Line, For Composite Laminate Material	WP008 02
Pulse-Echo, Longitudinal Wave Contact With Delay Line, For Composite Laminate Material	WP008 03
Pulse-Echo, Longitudinal, Contact Without Delay Line, For Composite Laminate Material	WP008 11
Pulse-Echo, Longitudinal Contact With Delay Line, For Composite Laminate Material	WP008 12

Alphabetical Index

Record of Applicable Technical Directives

None

1. OUTER WING TORQUE BOX SKIN.

2. Outer wing torque box skin is solid graphite epoxy laminate material. Surface finish is epoxy primer and polyurethane coatings. Figure 1 shows various areas where skin thickness changes will occur. Figure 2 dimensions and identifies areas of constant thickness.

3. **DEFECTS.** Inspect for delaminations in upper and lower wing skins. Example of defects that may develop in bonded assembly is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part number are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Unit
GD0504	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Unit
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch

Support Equipment Required (Continued)

NOTE

Alternate item type designations or part number are listed in parentheses.

Part Number or Type Designation	Nomenclature
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.950 Inch

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
6-143	Disposable Applicator
MIL-C-87962, TYPE 1 CLASS 4	Cleaning Cloth

9. **Preparation Of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with dry cleaning solvent or methyl isobutyl ketone moistened cloth to be sure inspection area(s) is free of contamination or foreign material.

b. On outer wing skin surface, locate and mark area(s) of constant thicknesses as shown in figure 2.

10. **Equipment Settings/Standardization/Setup For Solid Composite Laminate Areas.** Do equipment standardization/setup (WP008 02), except as below:

a. Set up for laminates less than 0.450 thick before inspecting laminates less than 0.450 thick. Set up for laminates less than 0.950 thick before inspecting laminates less than 0.950 thick.

b. Make sure trailing edge of initial pulse is located at less than 1 large division when 0.100 FBH response is 80 to 90 percent CRT height.

11. **Inspection Procedure For Solid Laminate Areas.** After doing applicable standardization, laminates less than 0.450 thick or laminates less than 0.950 thick, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2, (WP008 02), and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thicknesses are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height.

c. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 03).

d. Do paragraph 16.

12. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Unit
GD0504	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Unit
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch
74D111295-1007	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.950 Inch

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
6-143	Disposable Applicator
MIL-C-87962, TYPE 1 CLASS 4	Cleaning Cloth

13. **Preparation Of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with solvent moistened cloth to be sure inspection area(s) is free of contamination or foreign material.

b. On outer wing skin surface, locate and mark area(s) of constant thicknesses as shown in figure 2.

14. **Equipment Settings/Standardization/Setup For Solid Composite Laminate Areas.** Do equipment standardization/setup (WP008 11), except as below:

a. Set up for laminates less than 0.450 thick before inspecting laminates less than 0.450 thick. Set up for laminates less than 0.950 thick before inspecting laminates less than 0.950 thick.

b. Make sure trailing edge of initial pulse is located at less than 1 large division when 0.100 FBH response is 80 to 90 percent CRT height.

15. **Inspection Procedure For Solid Laminate Areas.** After doing applicable standardization, laminates less than 0.450 thick or laminates less than 0.950 thick, do pulse-echo inspection of solid laminate areas shown in figures 1 and 2, (WP008 11), and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thicknesses are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height.

c. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 12).

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

16. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean all couplant and marks from inspection area with dry cleaning solvent or methyl isobutyl ketone moistened cloth.

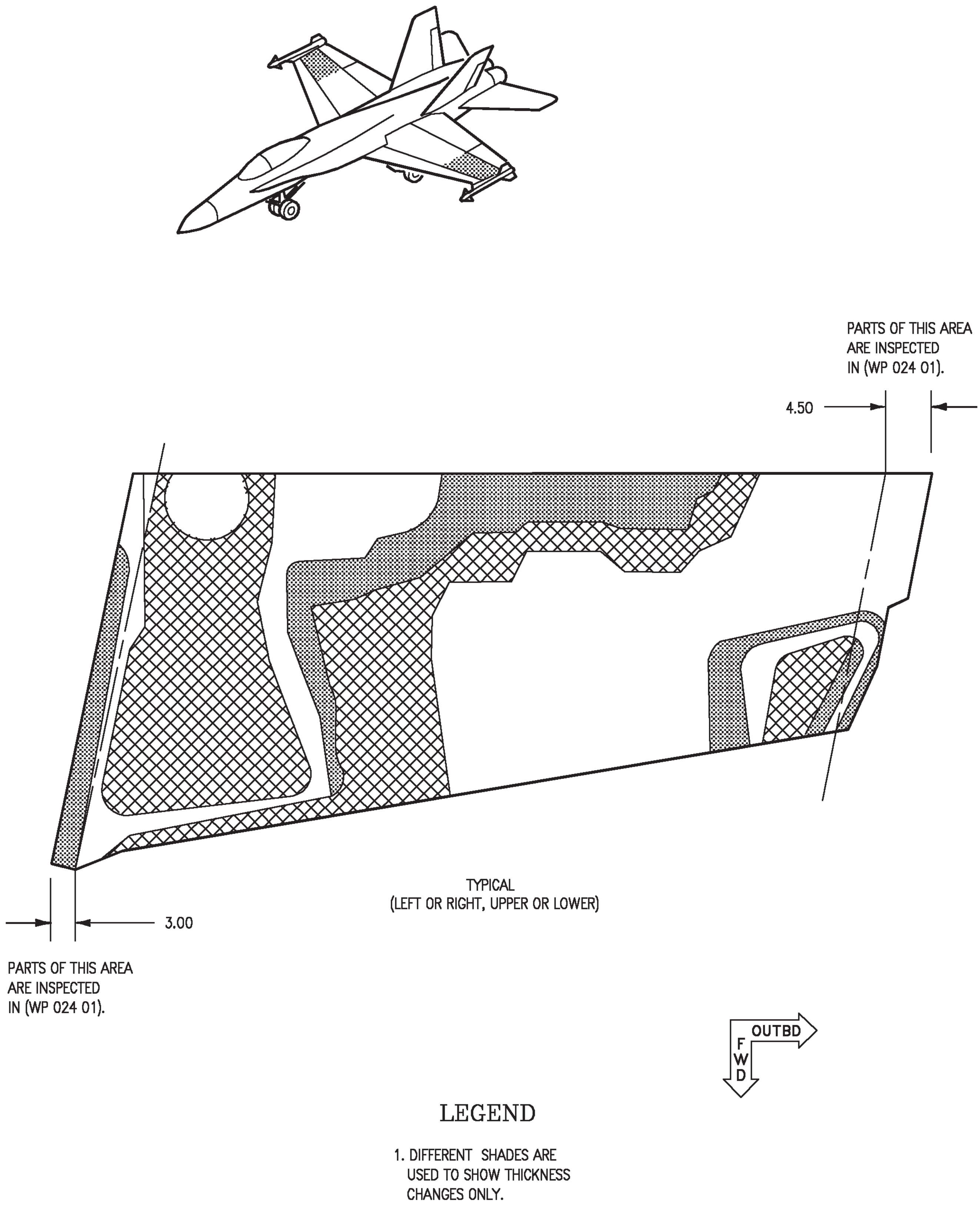


Figure 1. Outer Wing Skin Thickness Change Areas

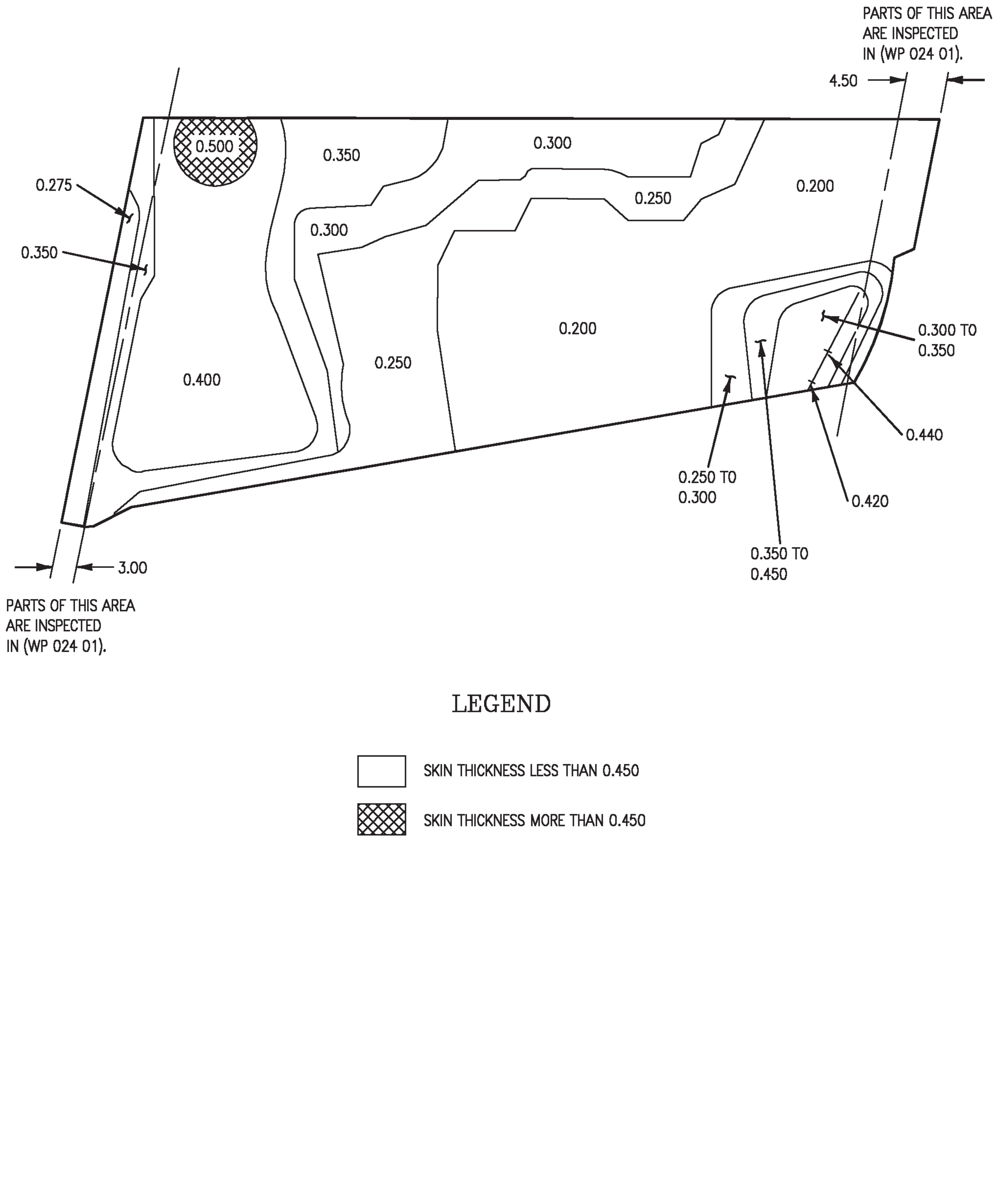


Figure 2. Outer Wing Skin Thickness Diagram (Sheet 1)

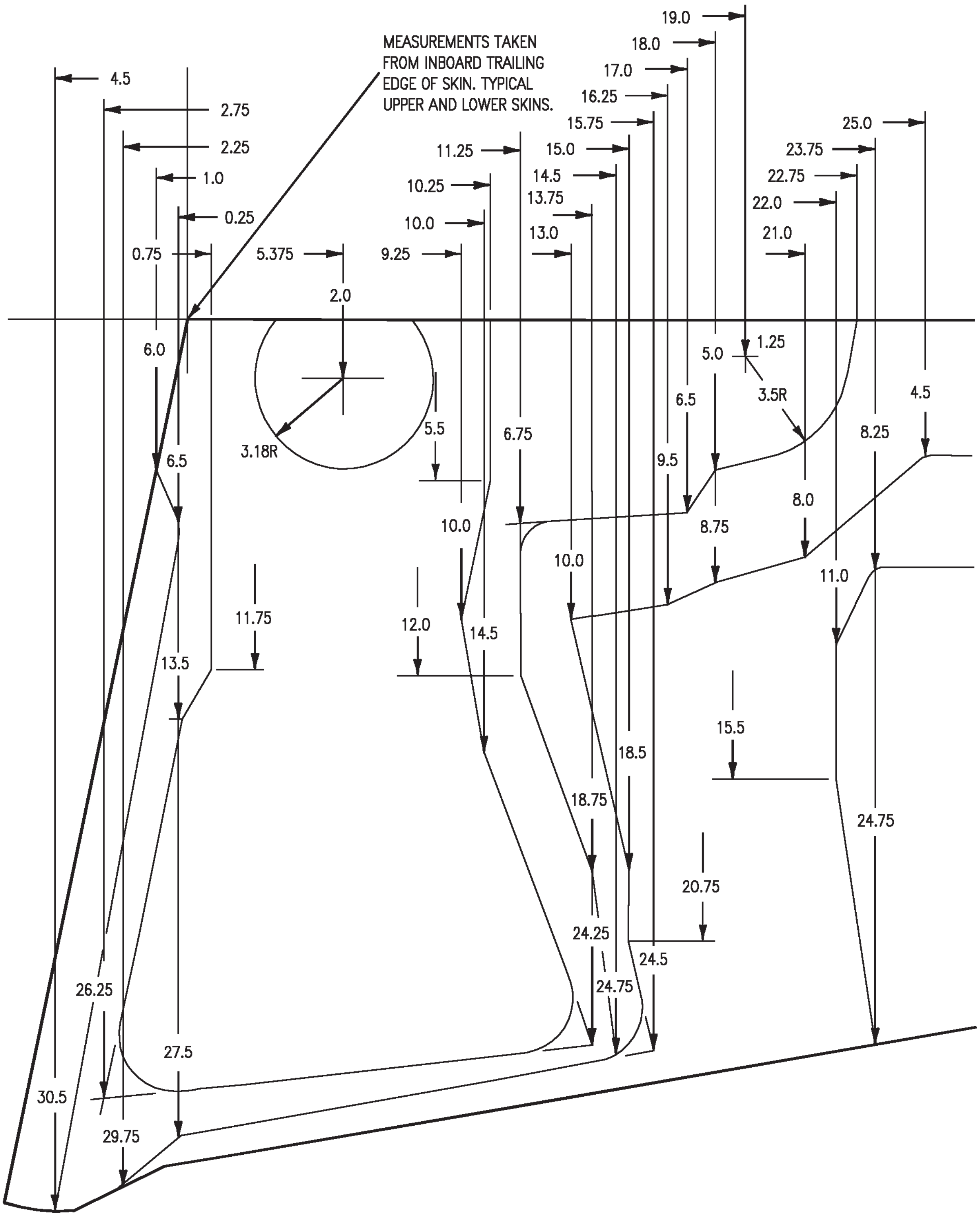


Figure 2. Outer Wing Skin Thickness Diagram (Sheet 2)

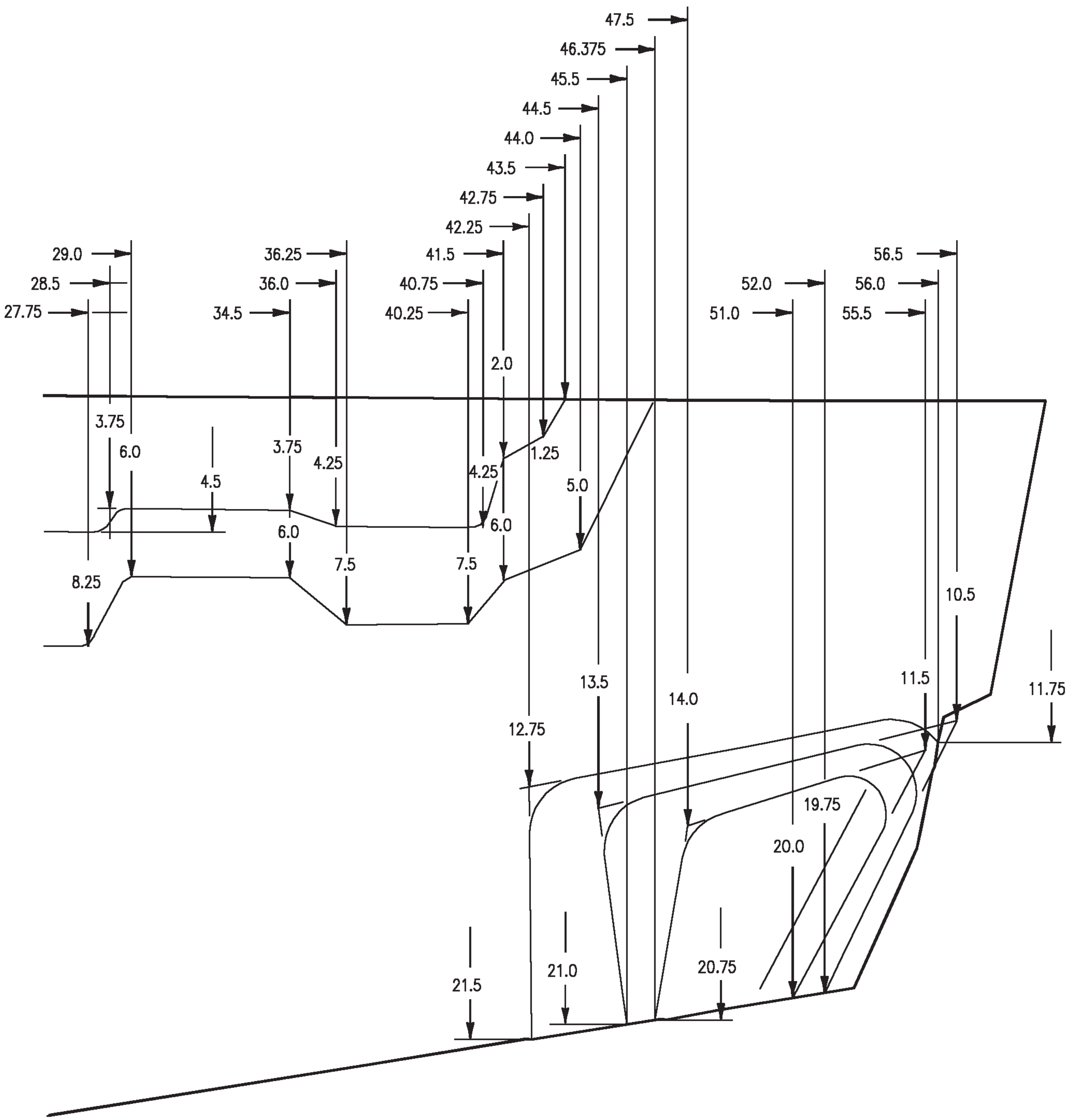


Figure 2. Outer Wing Skin Thickness Diagram (Sheet 3)

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

OUTER WING TORQUE BOX SKIN, WING FOLD RIB, AND MISSILE SUPPORT RIB AREAS

DELAMINATIONS

UPPER SKIN PART NO. 74A150600

LOWER SKIN PART NO. 74A150601

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection	A1-F18AC-SRM-300
General Information	WP003 00
Pulse-Echo, Longitudinal Wave Contact, Without Delay Line, For Composite Laminate Material	WP008 02
Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material	WP008 03
Pulse-Echo, Longitudinal Wave Contact, Without Delay Line, For Composite Laminate Material	WP008 11
Pulse-Echo, Longitudinal Wave Contact, With Delay Line, For Composite Laminate Material	WP008 12

Alphabetical Index

Record of Applicable Technical Directives

None

1. **OUTER WING TORQUE BOX SKIN, WING FOLD RIB, AND MISSILE SUPPORT RIB AREAS.** See figures 1 and 2.

2. Wing fold rib, missile support rib areas, and outer wing torque box skin is solid graphite epoxy laminate material. Surface finish is epoxy primer and polyurethane coatings.

3. **DEFECTS.** Inspect for delaminations in upper and lower skins. Example of defects that may

develop in laminate assembly is contained in (WP003 00).

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** No special access required.

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part number are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Contact, Delay Line Search Unit
GD0504	0°, 0.25 Dia, 5 MHz, Contact Delay Line, Search Unit
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

9. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection areas with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection areas are free of contamination or foreign material.

b. On surface of part, locate and mark inspection areas as shown in figures 1 and 2.

10. **Equipment Settings/Standardization/Setup For Solid Composite Laminate Areas.** Do equipment settings/standardization/setup (WP008 02), except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

NOTE

Several areas will be thicker than 0.450 inch, however, there is enough horizontal width for these areas to be shown.

a. Set up for laminates less than 0.450 inch thick before inspecting.

b. Make sure trailing edge of initial pulse is located at less than 1 large division when 0.100 inch FBH response is 80 to 90 percent CRT height.

11. **Inspection Procedure For Solid Composite Laminate Areas.** Do pulse-echo inspection of solid laminate areas, figure 1 and 2, (WP008 02), and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thicknesses are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 1.

c. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 03).

d. Do paragraph 16.

12. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0° ,0.25 Dia, 5 MHz, Contact, Delay Line Search Unit
GD0504	0° ,0.25 Dia, 5 MHz, Contact Delay Line, Search Unit
75D110175-1001	Graphite Epoxy Reference Standard Set Containing the Following:
74D111295-1009	Graphite Epoxy Flat Bottom Hole Reference Standard for Laminates Up to 0.450 Inch

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

13. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection area(s) with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection area(s) are free of contamination or foreign material.

b. On surface of part, locate and mark inspection areas as shown in figures 1 and 2.

14. **Equipment Settings/Standardization/ Setup For Solid Composite Laminate Areas.** Do equipment settings/standardization/setup (WP008 11), except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

NOTE

Several areas will be thicker than 0.450 inch, however, there is enough horizontal width for these areas to be shown.

a. Set up for laminates less than 0.450 thick before inspecting.

b. Make sure trailing edge of initial pulse is located at less than 1 large division when 0.100 FBH response is 80 to 90 percent CRT height.

15. **Inspection Procedure For Solid Composite Laminate Areas.** Do pulse-echo inspection of solid laminate areas, figure 1 and 2, (WP008 11), and as below:

a. Position search unit on inspection area where laminate thickness is known. Approximate thicknesses are shown in figures 1 and 2, this WP.

b. Make sure leading edge of back surface response is at correct location on horizontal base line when peak amplitude is 80 to 90 percent CRT height. See figure 3, CRT 1.

c. Map and identify flaws located near surface by doing pulse-echo contact delay line inspection (WP008 12).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

16. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean all couplant and marks from inspection area with dry cleaning solvent or methyl isobutyl ketone moistened cloth.

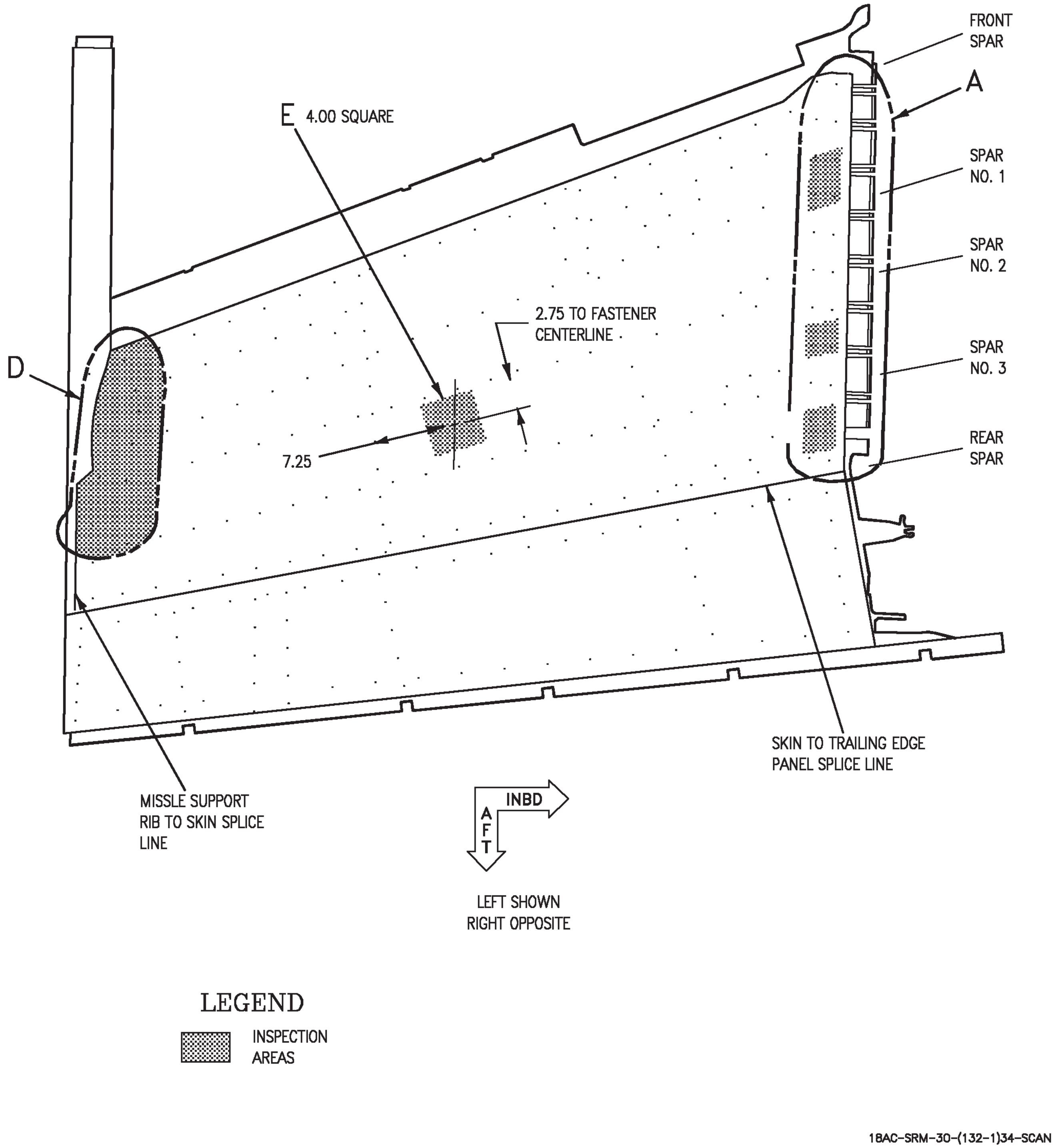
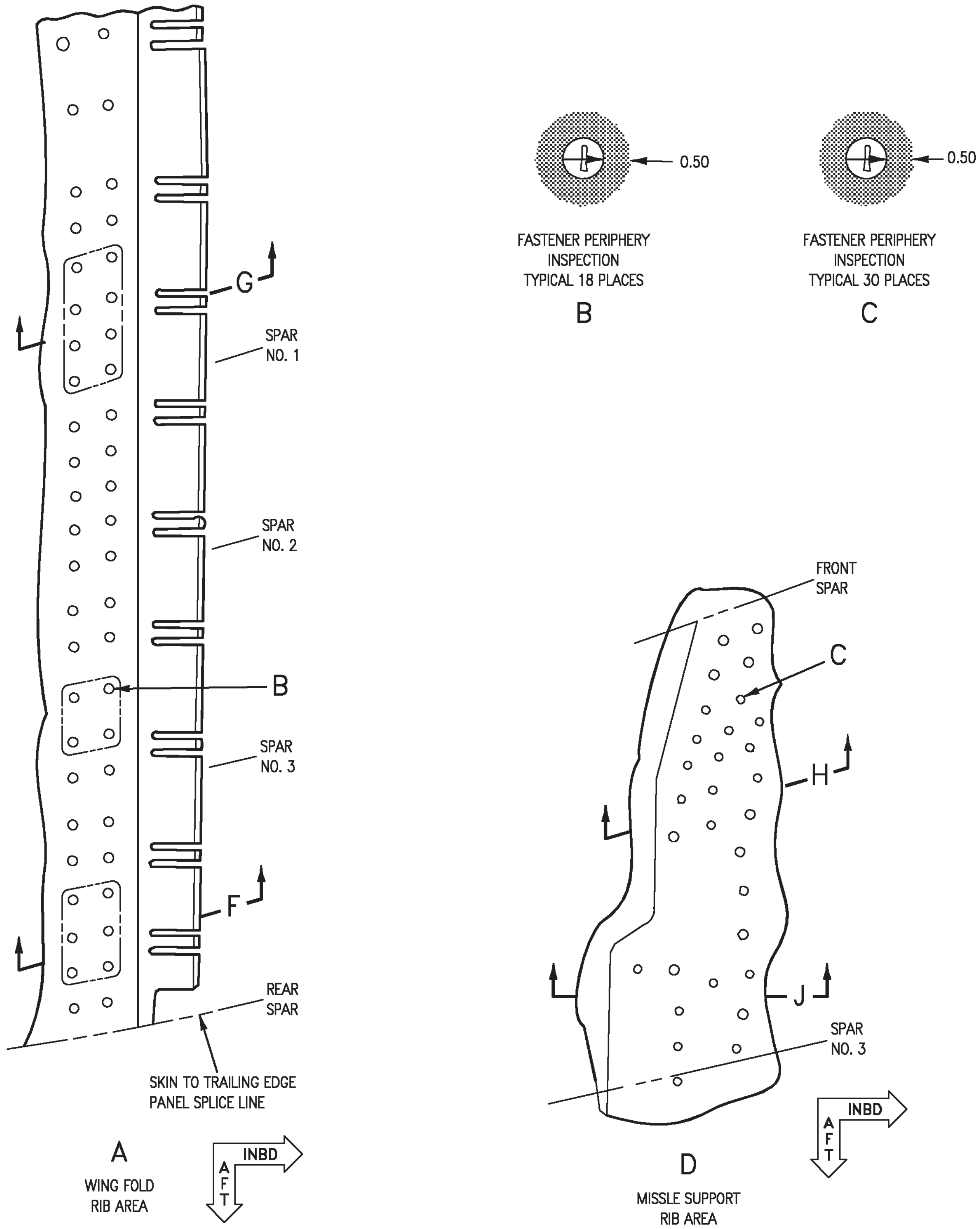


Figure 1. Outer Wing Upper Surface Inspection Areas (Sheet 1)



18AC-SRM-30-(132-2)34-SCAN

Figure 1. Outer Wing Upper Surface Inspection Areas (Sheet 2)

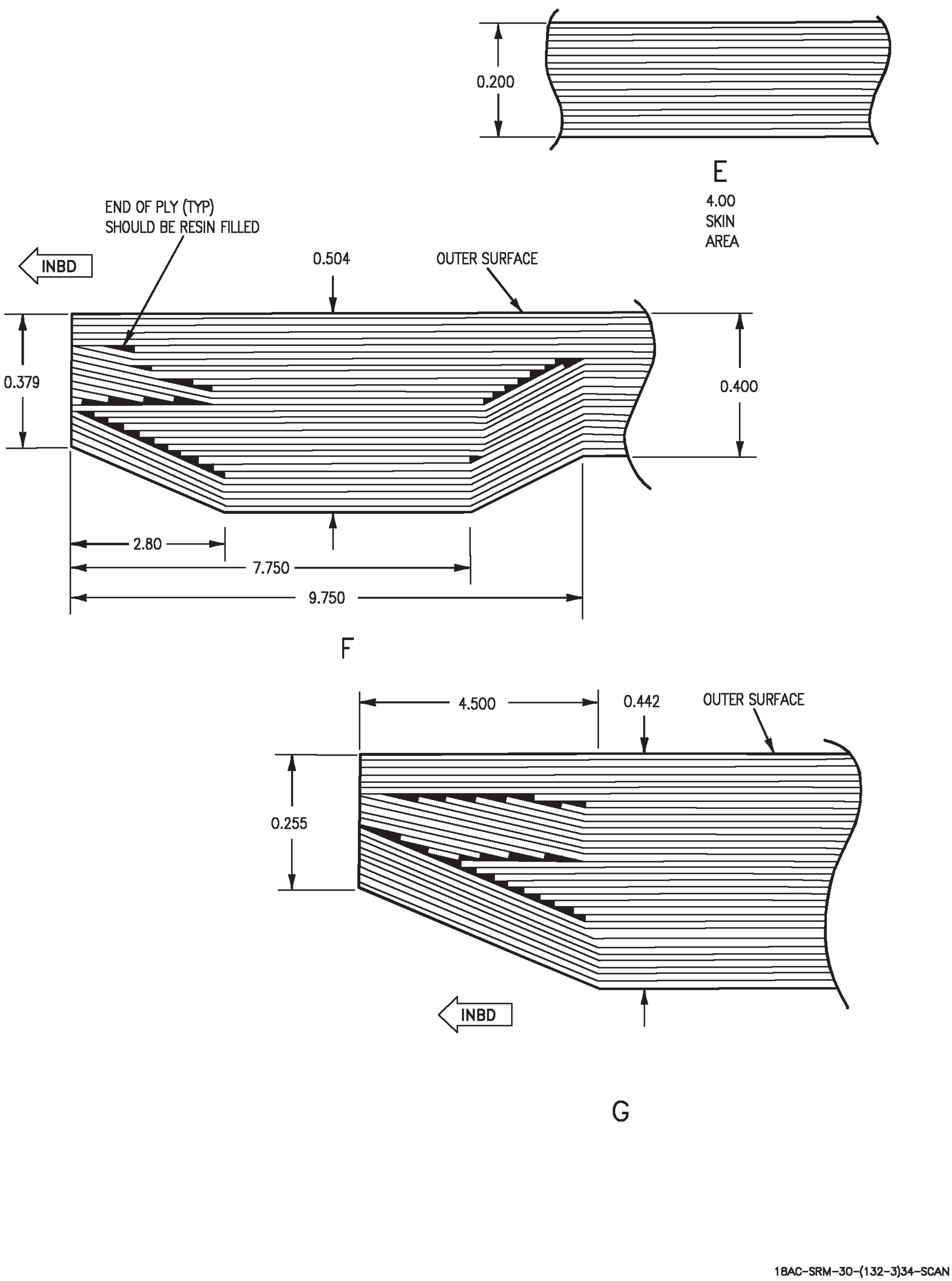
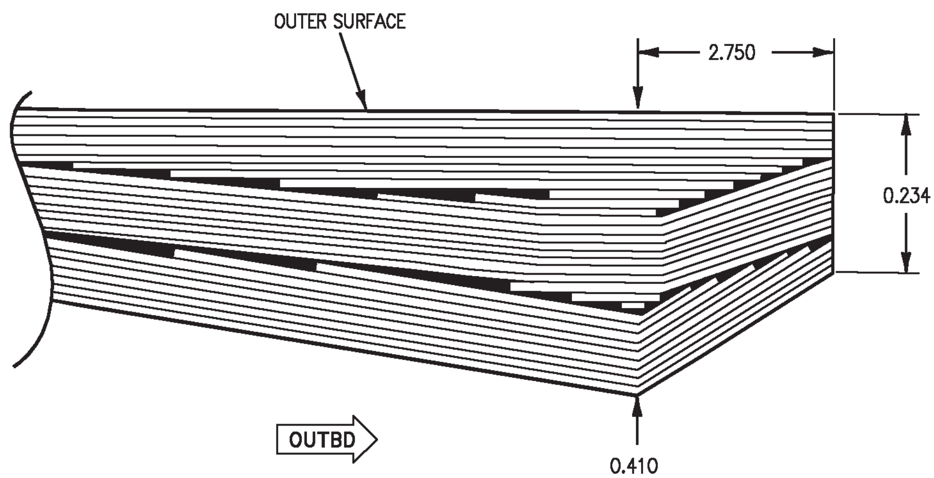
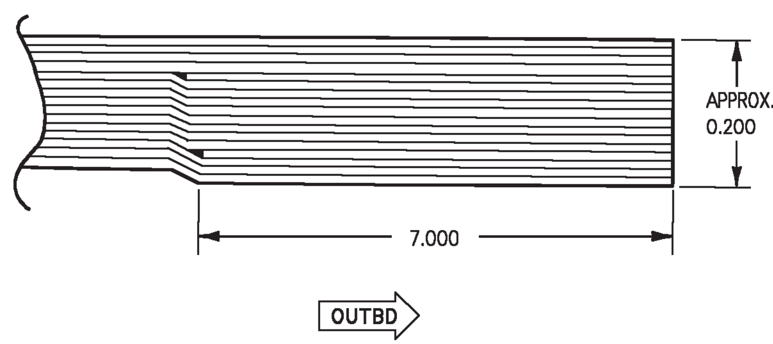


Figure 1. Outer Wing Upper Surface Inspection Areas (Sheet 3)



H



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18AC-SRM-30-(132-4)34-SCAN

Figure 1. Outer Wing Upper Surface Inspection Areas (Sheet 4)

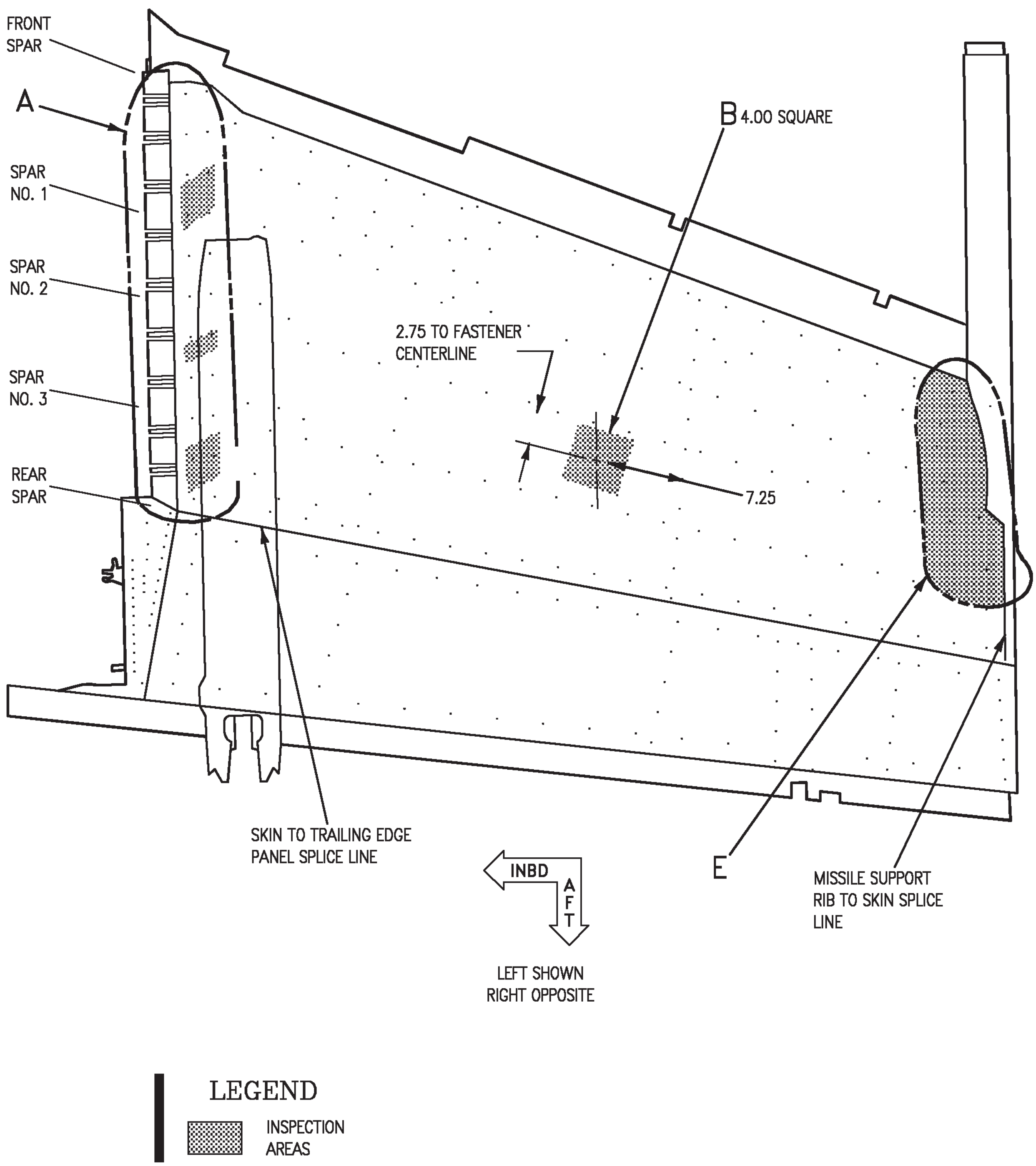


Figure 2. Outer Wing Lower Surface Inspection Areas (Sheet 1)

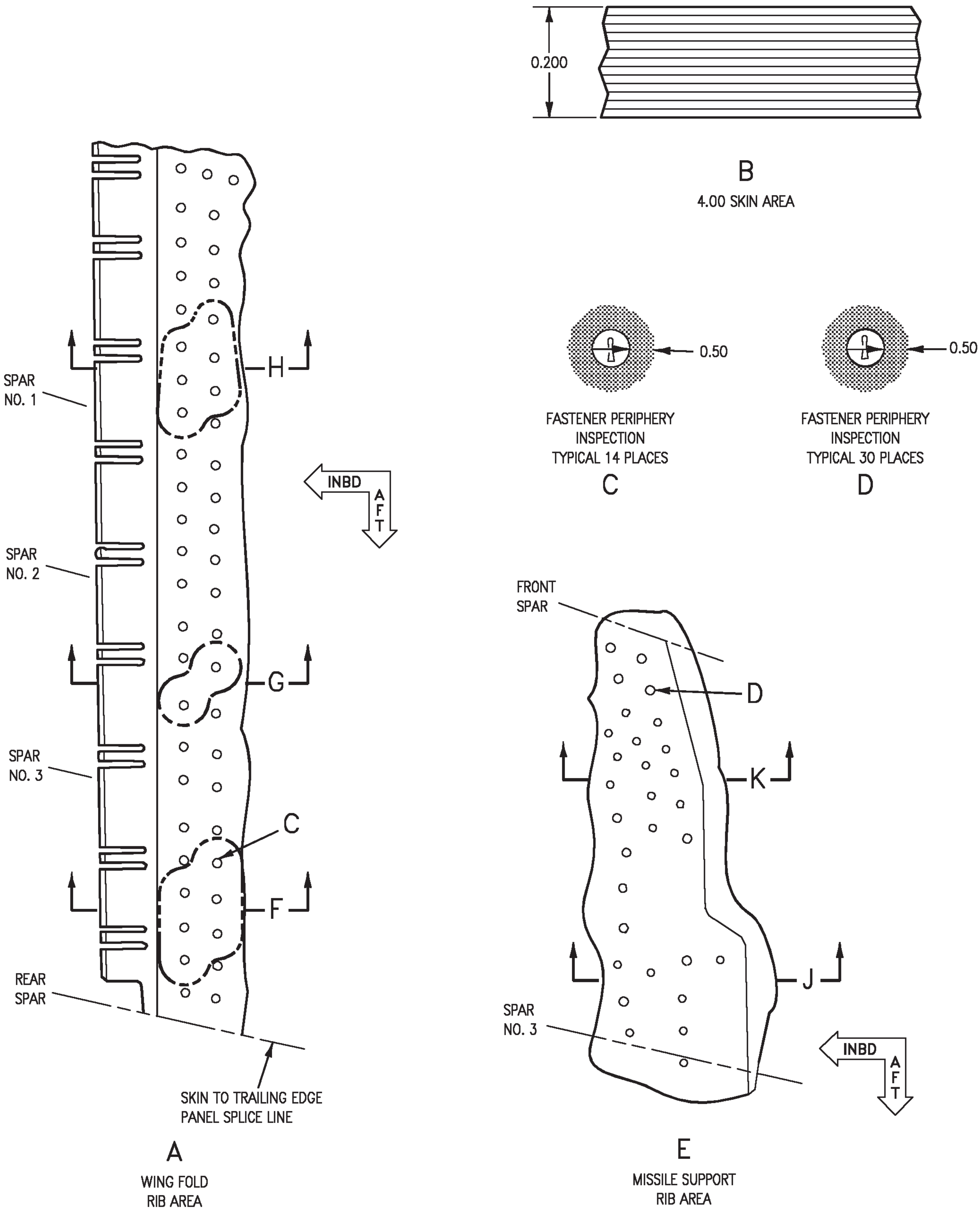


Figure 2. Outer Wing Lower Surface Inspection Areas (Sheet 2)

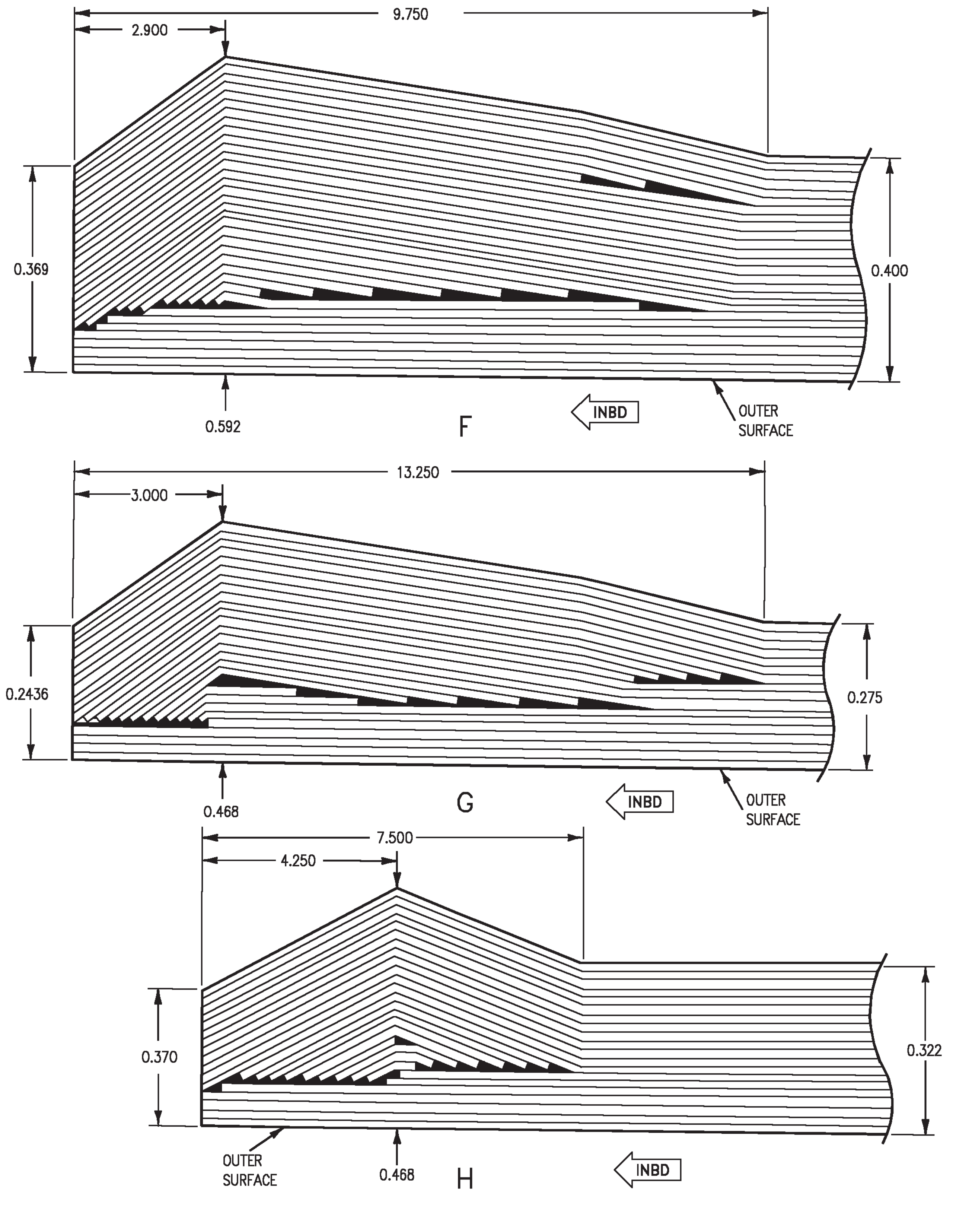
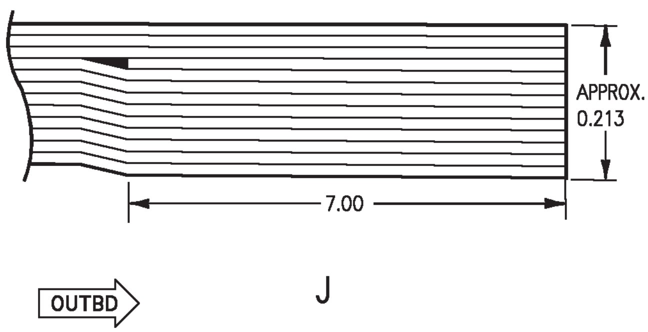


Figure 2. Outer Wing Lower Surface Inspection Areas (Sheet 3)



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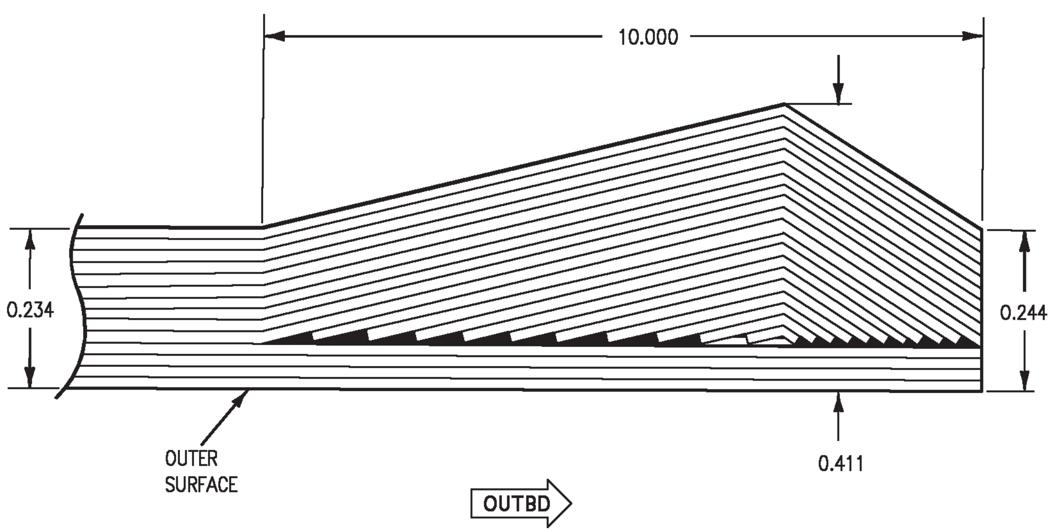


K

18AC-SRM-30-(133-4)34-SCAN

Figure 2. Outer Wing Lower Surface Inspection Areas (Sheet 4)

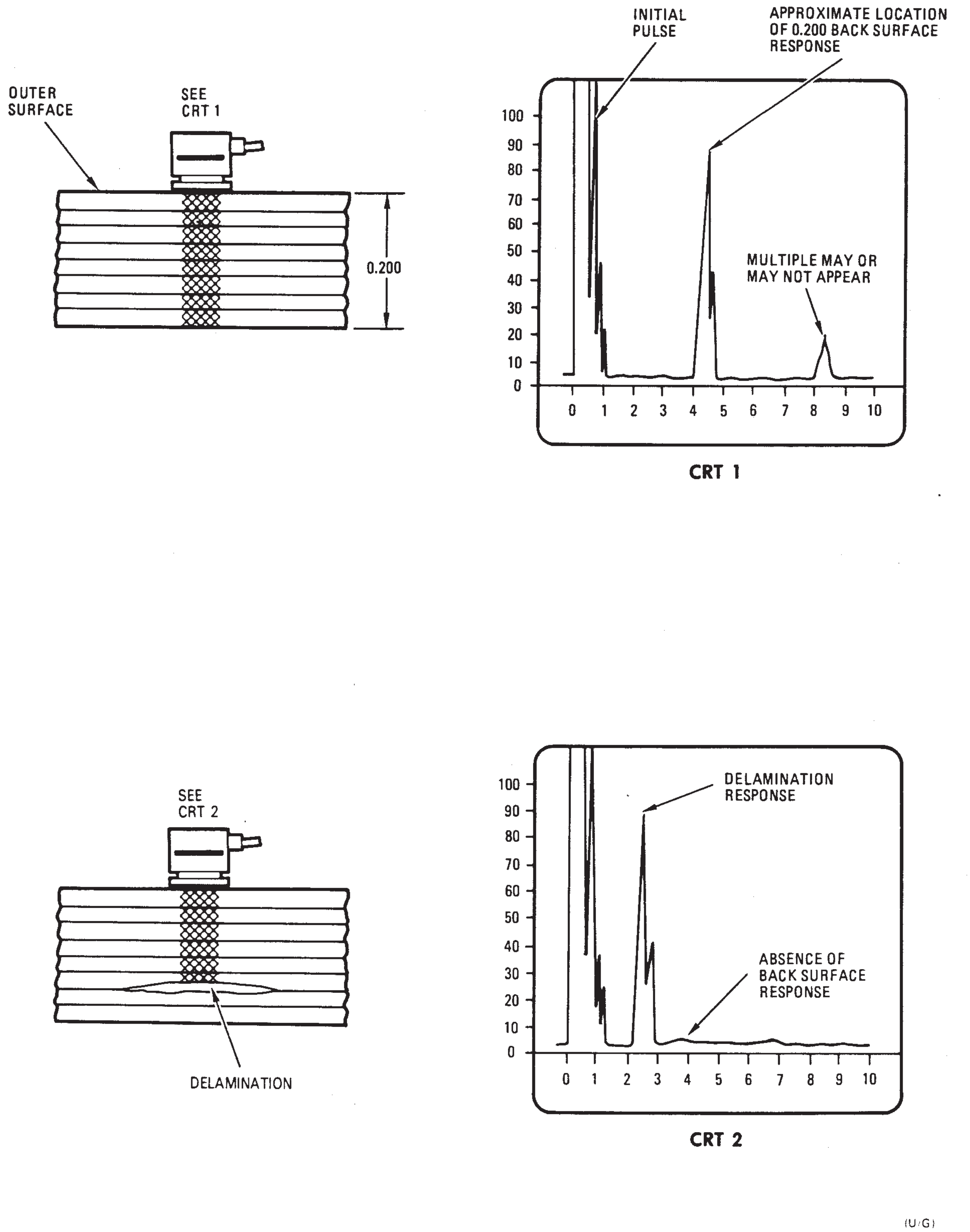


Figure 3. Outer Wing Upper and Lower Surfaces Typical Inspection Responses

INTERMEDIATE MAINTENANCE

NONDESTRUCTIVE INSPECTION

OUTER WING LOWER SKIN TO FOLD RIB JOINT

CRACKED OR BROKEN FASTENERS

This WP supersedes WP024 02, dated 15 March 1993.

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Line Maintenance Access Doors	A1-F18AC-LMM-010
Plane Captain Manual	A1-F18AC-PCM-000
Nondestructive Inspection	A1-F18AC-SRM-300
Pulse-Echo Longitudinal Wave, Contact, Without Delay Line for Metallic Materials	WP008 05

Alphabetical Index

Record of Applicable Technical Directives

None

1. OUTER WING LOWER SKIN TO FOLD RIB JOINT.

2. Outer wing lower skin to fold rib joint (fold rib joint) is made up of graphite epoxy skin, titanium fold rib, and aluminum spars. Fold rib joint is mechanically joined using ST3M760C, 5/16 diameter, PH13-8MO corrosion resistant steel fasteners. Fasteners are installed with clearance fit through graphite epoxy and interference fit through titanium and aluminum. Surface finish system is epoxy primer and polyurethane coatings.

3. **DEFECTS.** See figure 1. Inspect for broken or cracked fasteners in positions 1 through 20, 22 through 47, and 383. Fasteners in positions 21 and 384 are covered by fixed forward and aft fairings.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is ultrasonic.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do ultrasonic inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have missile encoder fairings, and Doors 159 L/R removed (A1-F18AC-LMM-010).

8. **ULTRASONIC METHOD USING C-398 ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
C-398 (303B)	Ultrasonic Flaw Detector
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Units
57A3052 or EQUIVALENT	45°,0.250 x 0.250, 5 MHz, Contact Delay Line Search Unit

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ST3M760C5-12,	Fastener
HLT53YC-( )-( )	
ST3M760C5-14,	Fastener
HLT53YC-( )-( )	
ST3M760C5-15,	Fastener
HLT53YC-( )-( )	
ST3M760C5-16,	Fastener
HLT53YC-( )-( )	
ST3M760C5-17,	Fastener
HLT53YC-( )-( )	
ST3M760C5-18,	Fastener
HLT53YC-( )-( )	

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ST3M760C5-( ), HLT53YC-( )-( )	Fastener, Broken Fastener Standard
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
COMMERCIAL	Tube Type Marker
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone

WARNING

Dry cleaning solvent and methyl Isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

9. **Preparation of Part.** Clean inspection area with solvent moistened cloth to make sure inspection area is free of contamination or foreign material.

10. **Equipment Settings/Standardization/ Setup.** Do general setup, including initial equipment settings (WP008 05), except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

a. Turn tester ON, allow 15 minutes warm-up.

b. Set tester front face setting.

NOTE

Following flaw detector settings are given as initial setup guide. Equipment differences may require use of alternate COURSE SWEEP RANGE, FREQ, FINE GAIN, COARSE GAIN, REP RATE, FINE SWEEP RANGE, DAMPING, REJECT, and VIDEO DISPLAY settings. If required, use alternate settings to produce optimum setup.

COARSE SWEEP RANGE	1.0 INCHES
ATTENUATORS	32 OUT 2,4,8,16 IN
FILTER	ON
COARSE SWEEP DELAY	0 - 3 INCHES
FINE SWEEP DELAY.	3 INCHES
FREQ	5 MHz
MODE	PULSE-ECHO
FINE GAIN	2
COARSE GAIN	4
REP RATE	AUTO
FINE SWEEP RANGE	4
DAMPING	6
REJECT	ZERO
VIDEO DISPLAY	FULL WAVE

NOTE

Following completion of general setup, initial pulse should be located at 0 on CRT horizontal baseline. See figure 2, CRT 1.

c. Apply couplant to heads of ST3M760C fasteners.

d. Position search unit on center of 12/64 grip length standard.

e. Adjust HORIZONTAL SWEEP FINE LENGTH, GAIN, and DAMPING to display response as shown on figure 2, CRT 2.

f. Position search unit on center of 15/64 grip length standard and verify response similar to figure 2, CRT 3.

g. Position search unit on center of 17/64 grip length standard and verify response similar to figure 2, CRT 4. Adjust DAMPING, REJECT, and GAIN until all three fastener standards display patterns similar to those shown on figure 2.

h. Position search unit on center of cut off fastener. Note multiple ring down pattern as shown on figure 3, CRT 1. This response is typical of broken fastener(s).

NOTE

No distance amplitude calibration (DAC) is required for this procedure.

11. **Inspection Procedures.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

Fasteners being inspected are factory installed Hi-Loc fasteners only. Any previously replaced fasteners, using blind fasteners, will not allow this procedure to be used.

a. Apply couplant to heads of fasteners to be inspected, see figure 1.

b. Position search unit on head of fastener to be inspected.

c. Compare received response to figure 2, CRT's 2, 3, or 4, as applicable. See figure 1 for correct grip length by fastener location.

d. Received response may include 1 or 2 intermediate echoes as shown on figure 3, CRT 2. Responses are due to interference between fastener and fold rib and are acceptable.

e. Any fastener response similar to cut off fastener should be marked. Any fastener head(s) missing should be noted.

f. If back echo pattern is lost or drops below 50 percent CRT height and response pattern similar to figure 3, CRT 1 is not received, do substeps below:

(1) Apply fresh couplant to fastener head(s).

(2) Reposition search unit on center of fastener.

(3) Inspect surface of fastener head for loose or chipped paint, dirt, or other obstructions and remove as required.

(4) Add up to 8 dB of GAIN to restore back echo pattern.

(5) Fastener(s) not displaying acceptable response pattern should be marked for further evaluation using angle beam inspection.

12. **Evaluation Procedure.**

a. Remove 57A2214 search unit from microdot cable and connect 57A3052 delay line search unit.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply fresh couplant to cut off fastener standard.

c. Position search unit on head of cut off fastener standard as shown on figure 4.

d. Move search unit back and forth across cut off fastener standard. As exit point of search unit approaches center of fastener head response is received from countersink part of fastener head, see figure 4, CRT 1.

e. With exit point of search unit near edge of fastener, cracked or broken fastener(s) will display an echo as shown on figure 4, CRT 2.

f. Position search unit on 12/64 grip length standard and note received response from end of short grip length fastener.

g. Apply fresh couplant to any suspect fasteners that were marked.

h. Scan across fastener head spanwise, chordwise, and on 45° angles. Any received response similar to that on figure 4, CRT 2 is not acceptable.

i. Do paragraphs 18 and 19.

13. **ULTRASONIC METHOD USING MXU-715/E ULTRASONIC FLAW DETECTOR.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
1642AS100-1	Ultrasonic Flaw Detector, MXU-715/E, Magnaflux
57A2271 or EQUIVALENT	Microdot to BNC Connecting Cable
57A2214 or EQUIVALENT	0°, 0.25 Dia, 5 MHz, Delay Line Contact Search Units
57A3052 or EQUIVALENT	45°, 0.250 x 0.250, 5 MHz, Contact Delay Line Search Unit

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
ST3M760C5-12, HLT53YC-( )-( )	Fastener
ST3M760C5-14, HLT53YC-( )-( )	Fastener
ST3M760C5-15, HLT53YC-( )-( )	Fastener
ST3M760C5-16, HLT53YC-( )-( )	Fastener
ST3M760C5-17, HLT53YC-( )-( )	Fastener
ST3M760C5-18, HLT53YC-( )-( )	Fastener
ST3M760C5-( ), HLT53YC-( )-( )	Fastener, Broken Fastener Standard
ULTRAGEL II	Ultrasonic Couplant
M83953-1 or -2	Pencil, Aircraft Marking
COMMERCIAL	Tube Type Marker
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone

14. **Preparation of Part.**

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection areas with dry cleaning solvent or methyl isobutyl ketone moistened cloth to make sure inspection areas are free of contamination or foreign material.

15. **Equipment Settings/Standardization/ Setup.** Do general setup, including initial equipment settings (WP008 05), except as below:

WARNING

Make sure safety precautions have been met for electrical, static, grounding when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

a. Turn tester ON, allow 15 minutes warm-up.

b. Set tester front face setting;

GAIN (dB)	(70 dB)
COURSE GAIN	7
FINE GAIN	0
HORIZONTAL SWEEP DELAY	
COURSE	50
FINE	9.0
HORIZONTAL SWEEP LENGTH	
COURSE	2
FINE	7.0

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

Following completion of general setup, initial pulse should be located at 0 on CRT horizontal baseline. See figure 2, CRT 1.

c. Apply couplant to heads of ST3M760C fasteners.

d. Position search unit on center of 12/64 grip length standard.

e. Adjust HORIZONTAL SWEEP FINE LENGTH, GAIN, and DAMPING to display response as shown on figure 2, CRT 2.

f. Position search unit on center of 15/64 grip length standard and verify response similar to figure 2, CRT 3.

g. Position search unit on center of 17/64 grip length standard and verify response similar to figure 2, CRT 4. Adjust DAMPING, REJECT, and GAIN until all three fastener standards display patterns similar to those shown on figure 2.

h. Position search unit on center of cut off fastener. Note multiple ring down pattern as shown on figure 3, CRT 1. This response is typical of broken fastener(s).

NOTE

No distance amplitude calibration (DAC) is required for this procedure.

16. **Inspection Procedures.**

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

NOTE

Fasteners being inspected are factory installed Hi-Loc fasteners only. Any previously replaced fasteners, using blind fasteners, will not allow this procedure to be used.

a. Apply couplant to heads of fasteners to be inspected, see figure 1.

b. Position search unit on head of fastener to be inspected.

c. Compare received response to figure 2, CRT's 2, 3, or 4, as applicable. See figure 1 for correct grip length by fastener location.

d. Received response may include 1 or 2 intermediate echoes as shown on figure 3, CRT 2. Responses are due to interference between fastener and fold rib and are acceptable.

e. Any fastener response similar to cut off fastener should be marked. Any fastener head(s) missing should be noted.

f. If back echo pattern is lost or drops below 50 percent CRT height and response pattern similar to figure 3, CRT 1 is not received, do substeps below:

(1) Apply fresh couplant to fastener head(s).

(2) Reposition search unit on center of fastener.

(3) Inspect surface of fastener head for loose or chipped paint, dirt, or other obstructions and remove as required.

(4) Add up to 8 dB of GAIN to restore back echo pattern.

(5) Fastener(s) not displaying acceptable response pattern should be marked for further evaluation using angle beam inspection.

17. **Evaluation Procedure.**

a. Remove 57A2214 search unit from microdot cable and connect 57A3052 delay line search unit.

WARNING

Couplant may cause eye irritation. Avoid contact with eyes. Wash thoroughly after handling.

b. Apply fresh couplant to cut off fastener standard.

c. Position search unit on head of cut off fastener standard as shown on figure 4.

d. Move search unit back and forth across cut off fastener standard. As exit point of search unit approaches center of fastener head response is received from countersink part of fastener head, see figure 4, CRT 1.

e. With exit point of search unit near edge of fastener, cracked or broken fastener(s) will display an echo as shown on figure 4, CRT 2.

f. Position search unit on 12/64 grip length standard and note received response from end of short grip length fastener.

g. Apply fresh couplant to any suspect fasteners that were marked.

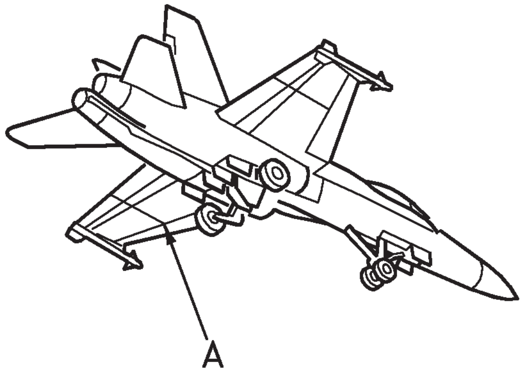
h. Scan across fastener head spanwise, chordwise, and on 45° angles. Any received response similar to that on figure 4, CRT 2 is not acceptable.

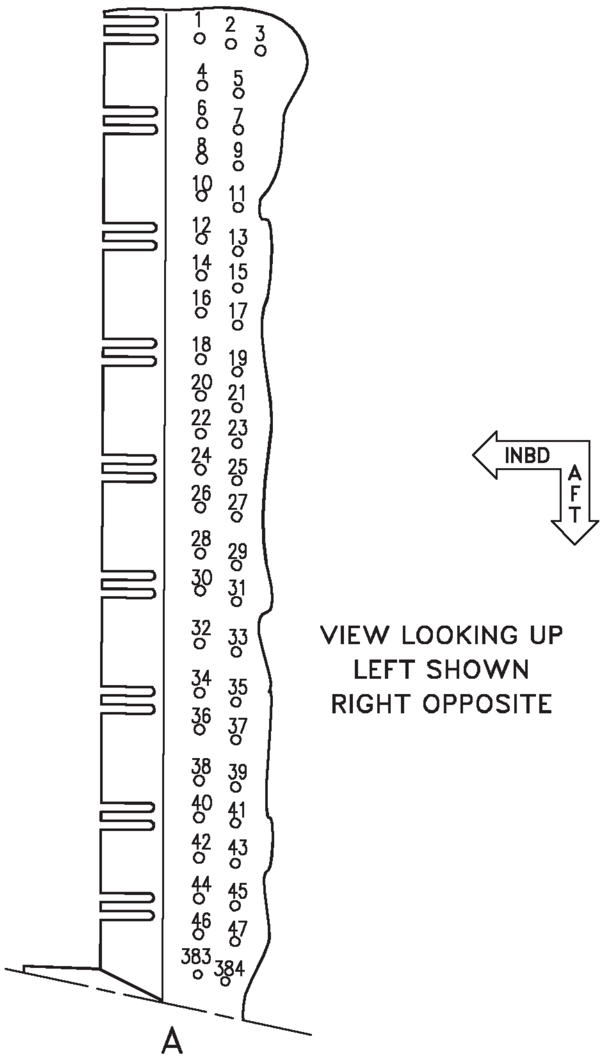
WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

18. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean couplant and markings from inspection area with dry cleaning solvent or methyl isobutyl ketone moistened cloth.

19. **SYSTEM SECURING.** Have missile encoder fairings, and doors 159 L/R reinstalled (A1-F18AC-LMM-010).





161353 THRU 163728

FASTENER HOLE LOCATION	GRIP LENGTH IN 1/16 INCH
1	17
2	17
3	17
4	15
5	17
6	15
7	17
8	15
9	17
10	12
11	12
12	14
13	16
14	14
15	16
16	14
17	16
18	14
19	16
20	14
21	16
22	12
23	12
24	14
25	16
26	14
27	16
28	14
29	16
30	14
31	16
32	12
33	12
34	14
35	16
36	14
37	16
38	14
39	16
40	14
41	16
42	12
43	12
44	14
45	18
46	14
47	18
383	14
384	18

163729 AND UP

FASTENER HOLE LOCATION	GRIP LENGTH IN 1/16 INCH
1	17
2	17
3	17
4	15
5	17
6	15
7	17
8	15
9	17
10	12
11	12
12	14
13	16
14	14
15	16
16	14
17	16
18	14
19	16
20	14
21	16
22	12
23	12
24	14
25	16
26	14
27	16
28	14
29	16
30	14
31	16
32	12
33	12
34	14
35	16
36	14
37	16
38	14
39	16
40	14
41	16
42	12
43	12
44	14
45	18
46	14
47	18
383	14
384	18

18AC-SRM-30-(357-1)35-CATI

Figure 1. Outer Wing Lower Skin Fasteners

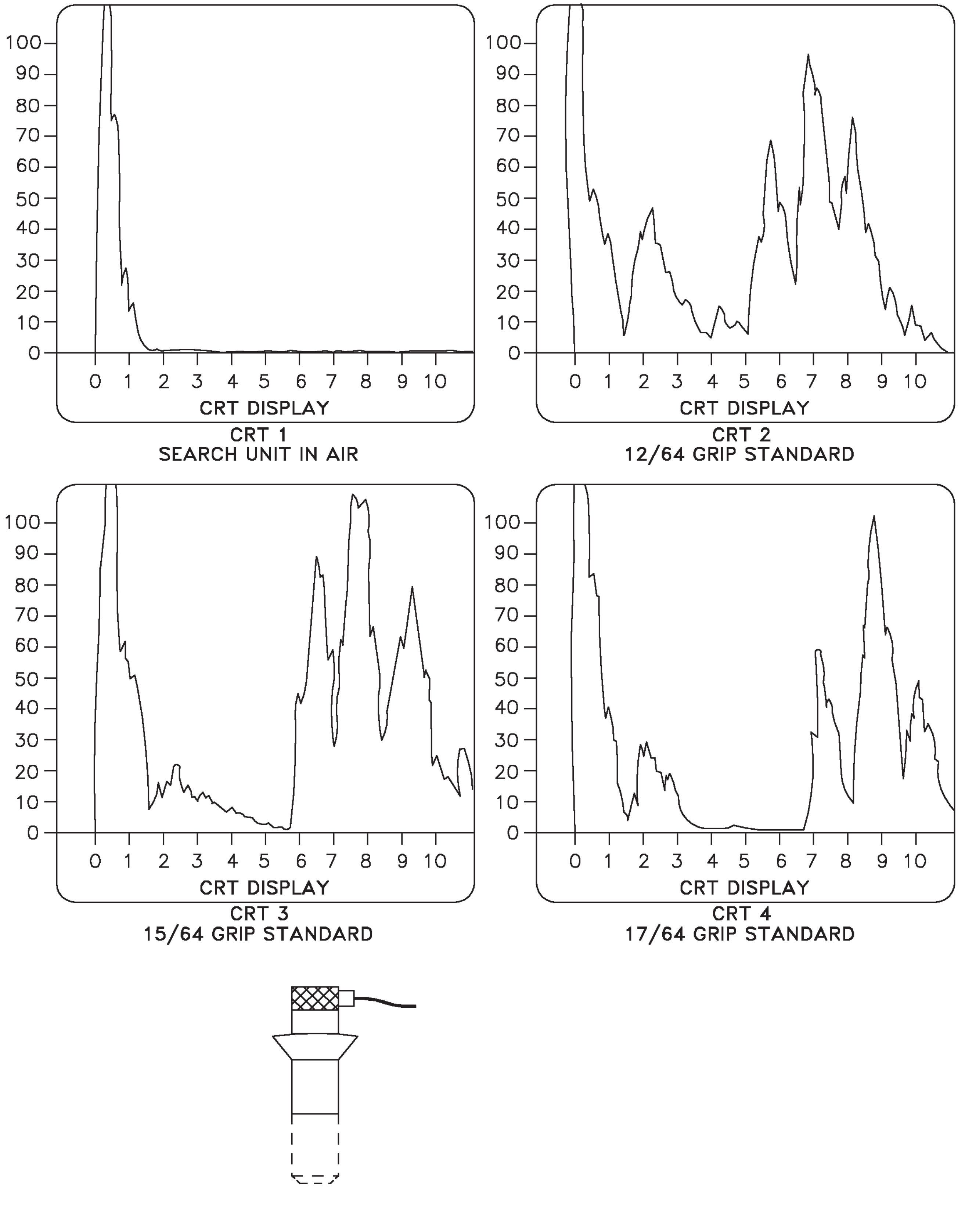


Figure 2. Standardization

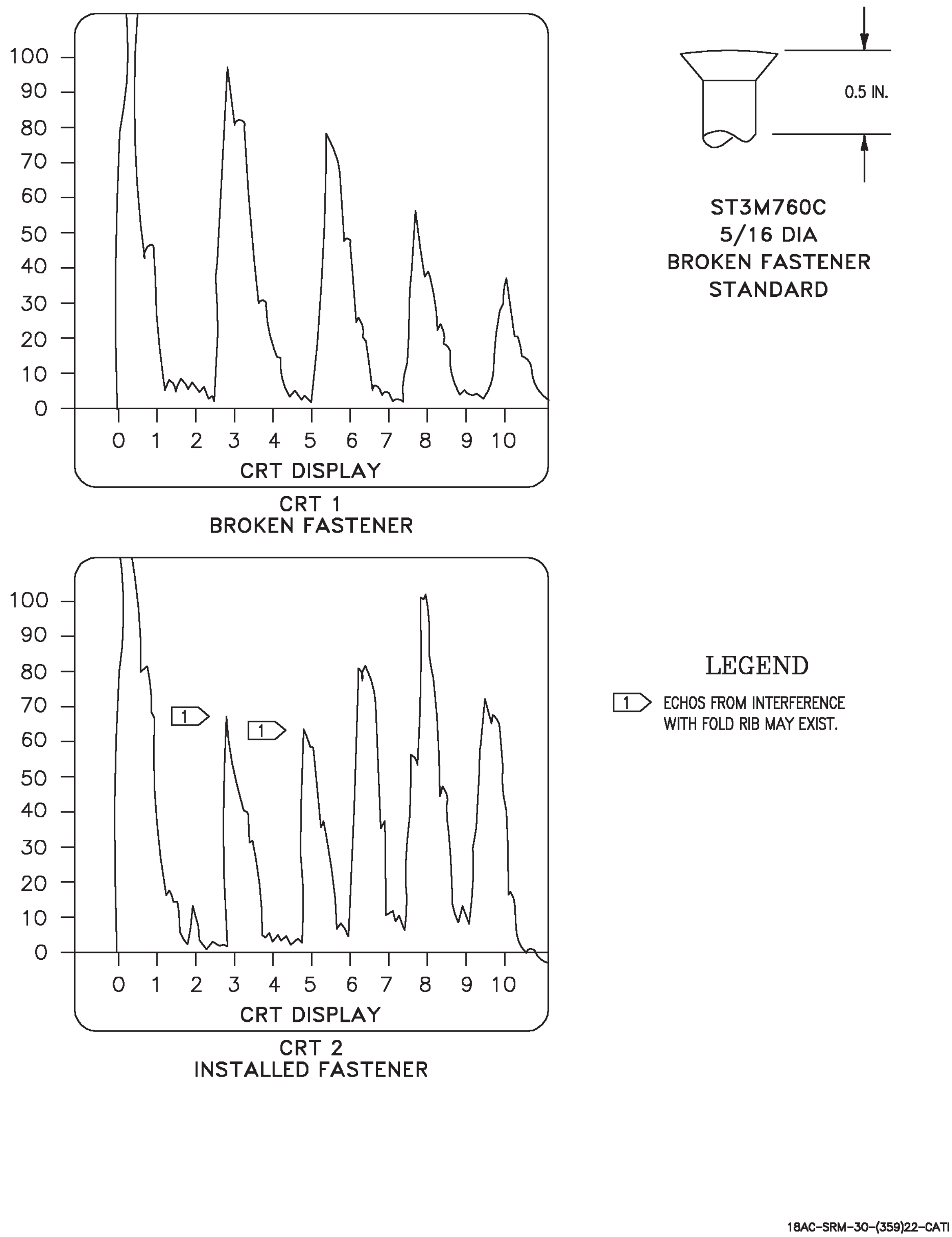


Figure 3. Intermediate Responses

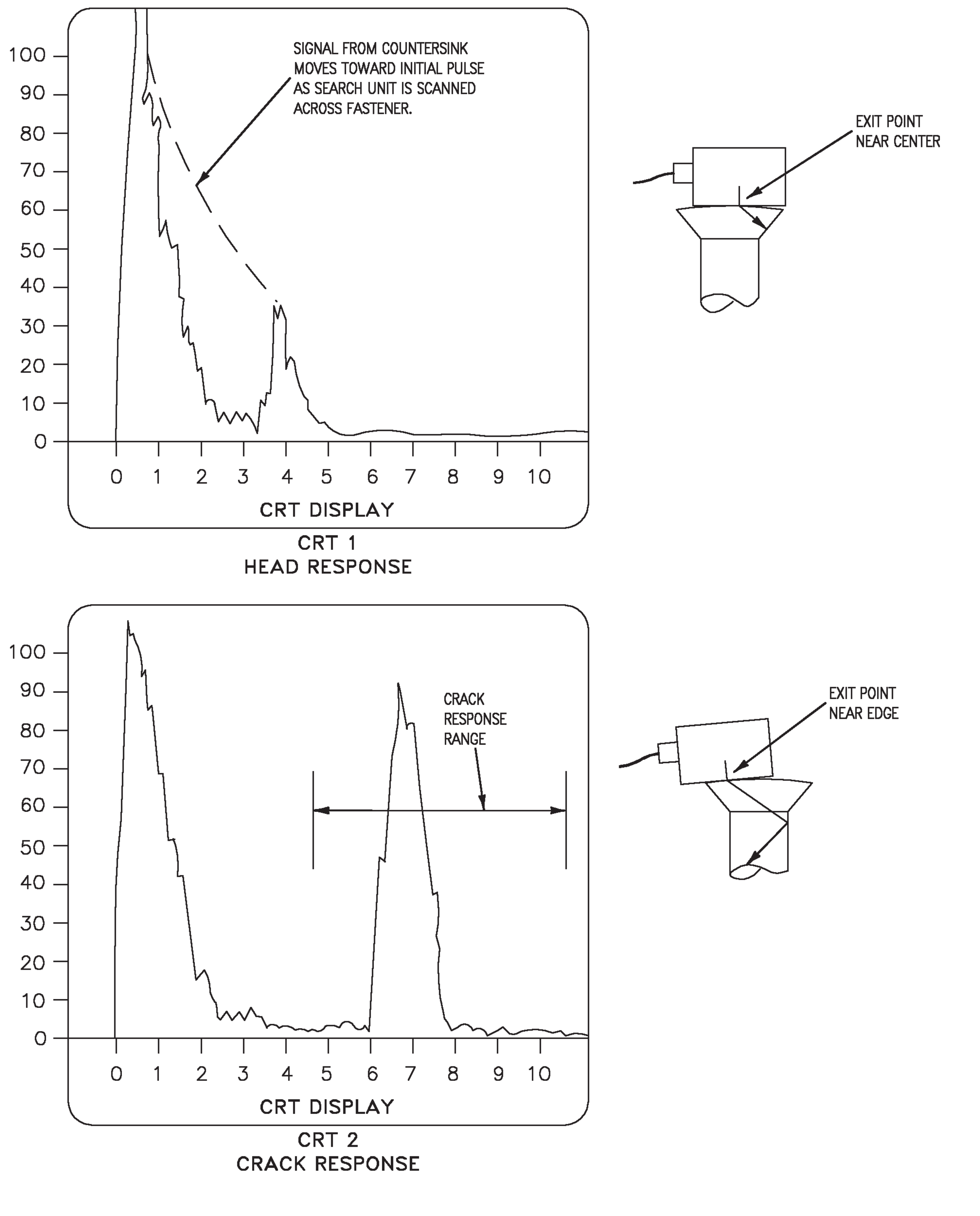


Figure 4. Evaluation Response

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CENTER FUSELAGE BULKHEAD Y453.000, INNER WING LOWER LUG ATTACH POINT FATIGUE CRACKS

PART NO. 74A324202

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Structure Repair, Wing	A1-F18AE-SRM-600
Inner Wing Removal and Installation	WP047 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Eddy Current Hole Inspection of Aluminum Alloys	WP007 01
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Finish System	WP012 00
Stripping	WP007 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16

Alphabetical Index

Record of Applicable Technical Directives

None

1. CENTER FUSELAGE BULKHEAD Y453.000, INNER WING LOWER LUG ATTACH POINT.

2. Center fuselage bulkhead Y453.000, inner wing lower lug attach point (attach point) is machined from 7075 aluminum alloy plate. Installed in attach point is force mated copper beryllium bushing. Bulkhead is finished with ion vapor deposition (IVD) aluminum coating. Surface finish is epoxy primer.

3. **DEFECTS.** Inspect area around attach point and lug flange fastener holes for fatigue cracks, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044..

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
Fabricate, See Figure 2	Eddy Current Reference Standard, Aluminum
6193	Multiple Coil Eddy Current Probe, Ideal Specialty Co.
1RR90F-6-1/2	Right Angle Surface Probe, GK Engineering
—	Wing Attach Lug Eddy Current Probe Guide
6200-5/16	Bolt Hole Probe, 5/16 Dia, Ideal Specialty Co.

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone

Materials Required (Continued)

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

Do not remove bushing.

8. **Preparation of Part.** Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.**

a. For flat open areas around lug attach point, see figure 1, do ED520 Flaw Detector Setup (WP007 00) except as below:

(1) Use multiple coil surface probe.

(2) Standardize using notch A of reference standard, see figure 2.

b. For areas on lug attach point near edge radius or bushings, see figure 3, do ED520 Flaw Detector Setup (WP007 00) except use 1RR90F-6-1/2 right angle surface probe.

10. **Inspection Procedure.**

a. For flat open areas on lug attach point, see figure 1, do Inspection Procedure (WP007 00) and refer to (NAVAIR 01-1A-16) except as below:

(1) Position probe on flat smooth surface in inspection area.

(2) Use BALANCE to set meter needle at 250 microamperes.

NOTE

When probe is moved near edge of part, fastener hole, or radius, meter needle may gradually move down scale. If required, BALANCE may be used to return meter needle to 250 microamperes and scan parallel to edge or radius.

(3) Scan inspection areas as shown in figure 1. Scan at constant speed, no faster than speed used for standardization of equipment. After each scan, index probe 3/8-inch, 90° to scan direction, and continue next scan.

(4) Mark all areas with aircraft marking pencil where sharp downscale deflection of meter needle indicates crack.

(5) Using 1RR90F-6-1/2 right angle surface probe, probe guide, and Inspection Procedure (WP007 00), reinspect all marked areas to accurately locate cracks.

b. For areas on lug attach point near radius or bushing, see figure 3, do ED520 Flaw Detector Setup (WP007 00) except use 1RR90F-6-1/2 right angle surface probe.

11. **Equipment Settings/Standardization/Setup For Flange Fastener Holes.** Do ED520 Flaw Detector Setup (WP007 01) using 5/16 diameter probe.

12. **Inspection Procedure for Flange Fastener Holes.** Do Inspection Procedure (WP007 01).

13. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Fluorescent penetrant inspection may be used to verify indications detected by primary inspection method.

14. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES.

15. **Preparation of Aircraft.** Same as primary inspection method.

16. **Access.** Same as primary inspection method.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
—	5 to 14 X Pocket Magnifier
M-16 (ZB-26)	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
A-A-883, TYPE1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
ZZ-G-381, TYPE1 STYLE1	Chemical Gloves, Rubber Gloves
AA1048TY1CL1GRIT 400X9X11	Aluminum Oxide Abrasive Cloth

17. **Preparation of Part.**

CAUTION

Mechanical or abrasive finish removal may cause damage to (IVD) coating.

a. Have finish system removed from inspection area(s) (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection area(s) with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

18. **Inspection Procedure.**

a. Do type I, method C fluorescent penetrant inspection (WP004 00 and NAVAIR 01-1A-16).

b. After removing excess penetrant, spray thin film of developer, which is part of inspection kit, on inspection surface.

c. Use black light and 14 × magnifier to view inspection area for cracks.

d. Evaluate indications, mark location of any defect with aircraft marking pencil and record.

19. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

a. Clean inspection material from part with solvent moistened cloth.

b. Refinish inspection area (A1-F18AC-SRM-500, WP012 00).

20. **SYSTEM SECURING.** Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

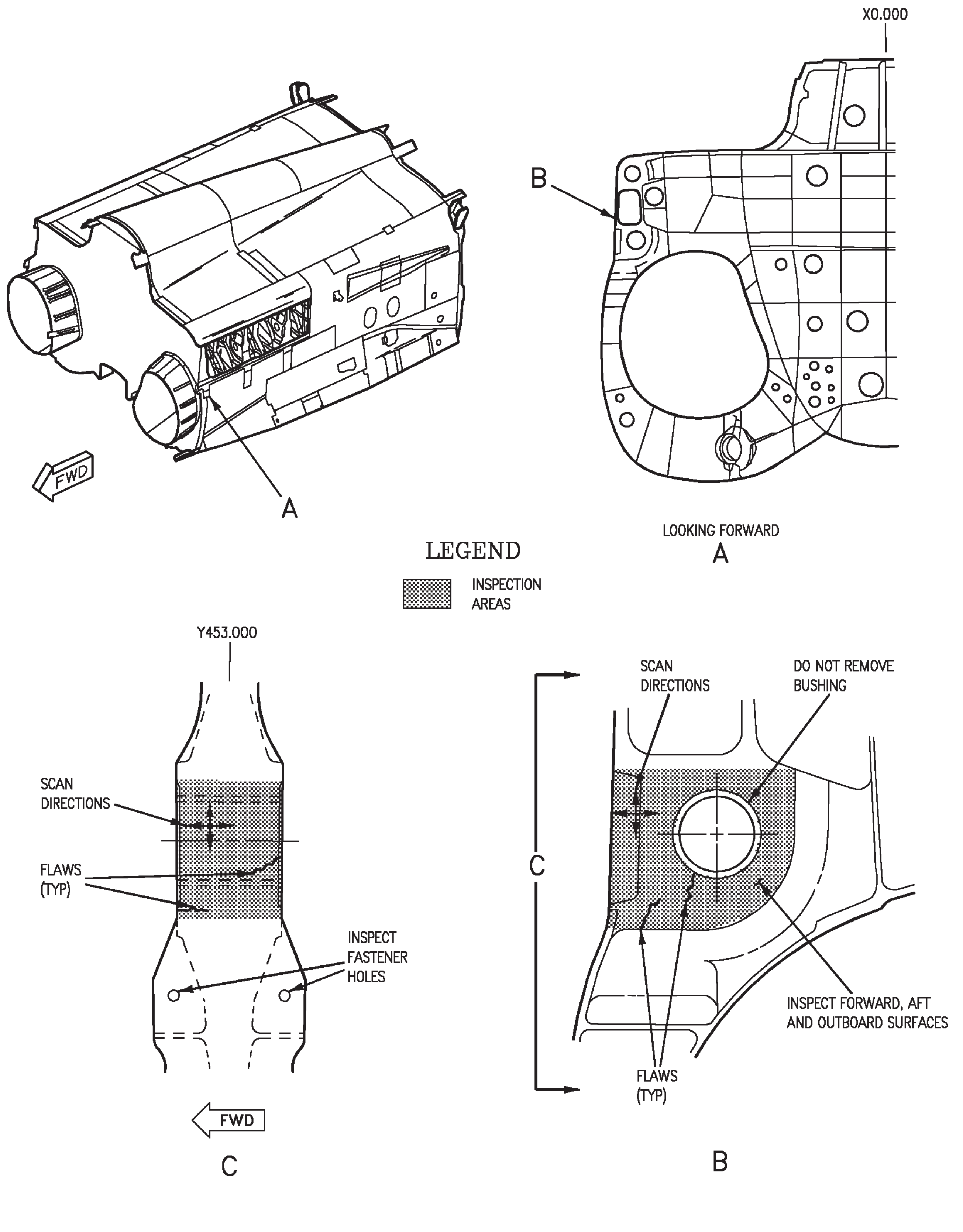
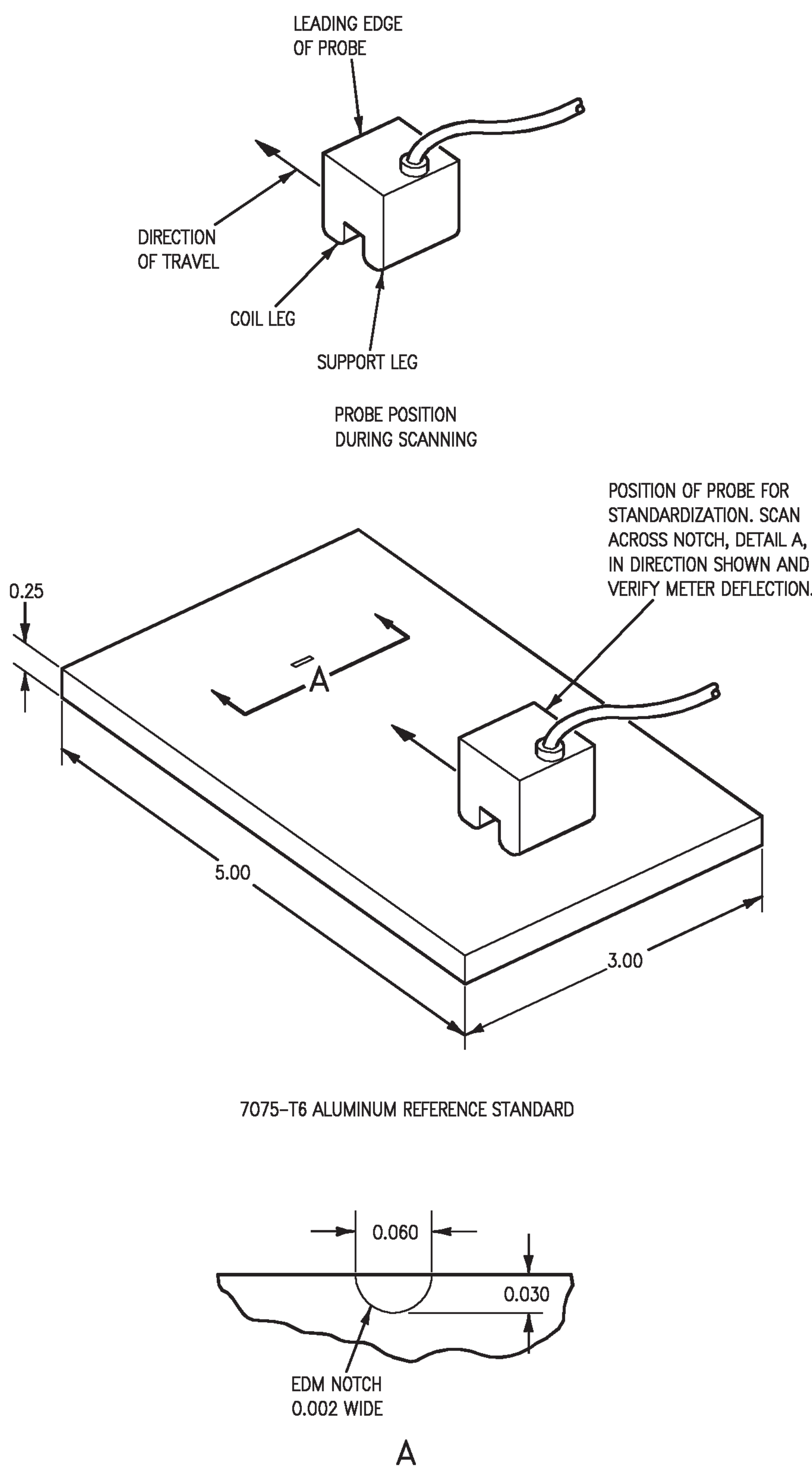


Figure 1. Center Fuselage Bulkhead Y453.000, Inner Wing Lower Lug Attach Point; Inspection Areas, Scan Directions, and Typical Flaws



18AC-SRM-30-(136-1)34-CATI

Figure 2. Standardization on EDM Notched Reference Standard

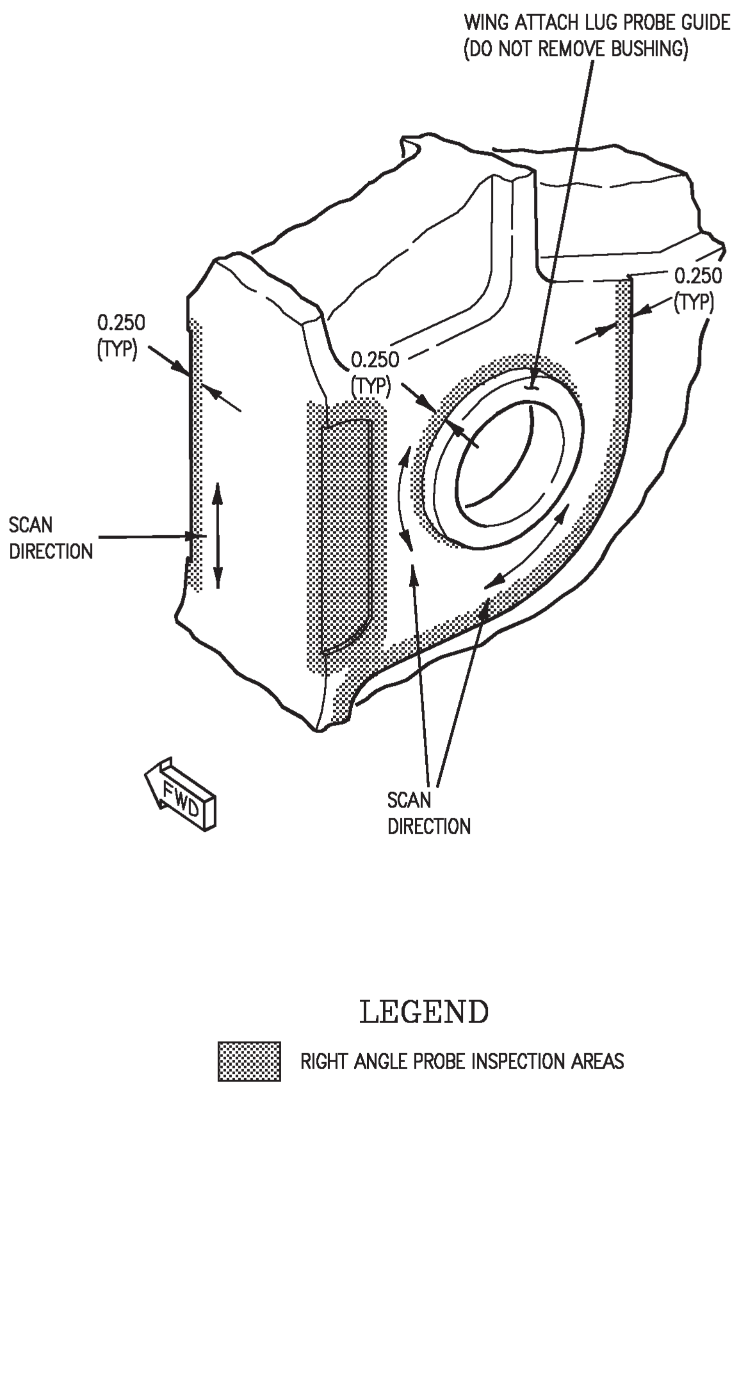


Figure 3. Right Angle Probe Inspection Areas

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CENTER FUSELAGE BULKHEAD Y453.000, UPPER FLANGE STEP AND TRANSITION RADII

FATIGUE CRACKS

PART NO. 74A324202

EFFECTIVITY: 161353 THRU 161704

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Line Maintenance Access Doors	A1-F18AC-LMM-010
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Finish System	WP012 00
Stripping	WP007 00
Nondestructive Inspection Methods	NAVAIR 01-1A-16

Alphabetical Index

Record of Applicable Technical Directives

None

1. CENTER FUSELAGE BULKHEAD Y453.000, UPPER FLANGE STEP AND TRANSITION RADII.

2. Center fuselage bulkhead Y453.000, upper flange step and transition radii (upper flange step and transition radii) is machined from 7075 aluminum plate. Surface finish is ion vapor deposition (IVD), aluminum, and epoxy primer.

3. **DEFECTS.** Inspect upper flange step and transition radii for fatigue cracks, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and

certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have door 41 removed (A1-F18AC-LMM-010).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
1RR90F-6-1/2	Right Angle Surface Probe GK Engineering

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean inspection areas with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** Do ED520 Flaw Detector Setup (WP007 00) using right angle surface probe (probe).

10. **Inspection Procedure.**

a. For upper flange step radii do Inspection Procedure (WP007 00) except as below:

(1) Position probe tip at base of radius as shown in figure 2, position 1.

(2) Use BALANCE to set meter needle to 250 microamperes.

NOTE

As probe is moved along radius and near edge of part, meter needle may gradually move up or down scale.

(3) Scan along radius as shown in figure 2.

(4) Mark area(s) with aircraft marking pencil where repeatable, sharp down scale deflection of meter needle indicates crack.

(5) Rotate angle of probe tip approximately 45° and repeat substeps (1) through (4), see figure 2, position 2.

b. For upper flange transition radii and near by flat area, see figure 1, do Inspection Procedure (WP007 00) except as below:

(1) Position probe tip at base of forward radius with tip rotated 45° to upper flange surface, see figure 2, position 2.

(2) Use BALANCE to set meter needle to 250 microamperes.

NOTE

As probe is moved along flat and near edge of part, meter needle may gradually move up or down scale.

(3) Scan along forward edge of flange and radius as shown in figure 2.

(4) Repeat substeps (1) through (3) for aft edge of flange and radius.

(5) Position probe tip on flat area of upper flange inspection area away from radius or edge of part.

(6) Use BALANCE to set meter needle to 250 microamperes.

NOTE

As probe is moved along or near radius or edge of part, meter needle may move gradually up or down scale. If required, BALANCE may be used to return meter needle to 250 microamperes and scan parallel to edge or part radius.

(7) Scan area near transition radii in direction shown in figure 2.

(8) Mark area(s) with aircraft marking pencil where repeatable, sharp down scale deflection of meter needle indicates crack.

NOTE

Use penetrant inspection to verify eddy current crack indications.

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Flourescent penetrant inspection may be used to verify indications detected by primary inspection method.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

13. **Preparation of Aircraft.** Same as primary inspection method.

14. **Access.** Same as primary inspection method.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
—	14 X Magnifier
M-16	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ke-tone
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
ZZ-G-381 TYPE 1, STYLE 1, SMALL, MEDIUM, LARGE	Chemical Gloves, Rubber Gloves
AA1048 TYICL1GRIT 400X9X11	Aluminum Oxide Abrasive Cloth
MIL-C-87962, TYPE 1	Cleaning Cloth

15. **Preparation of Part.**

CAUTION

Mechanical or abrasive finish removal may cause damage to IVD coating.

a. Have finish system removed from inspection area(s), see figure 1, and (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection area(s) with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

16. **Inspection Procedure.**

a. Do type I, method C fluorescent penetrant inspection (WP004 00 and NAVAIR 01-1A-16).

b. After removing excess penetrant, spray thin film of developer, which is part of inspection kit, on inspection surface.

c. Use black light and 14 X magnifier to view inspection area for cracks.

d. Evaluate indications, mark location of any defect with aircraft marking pencil, and record.

17. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

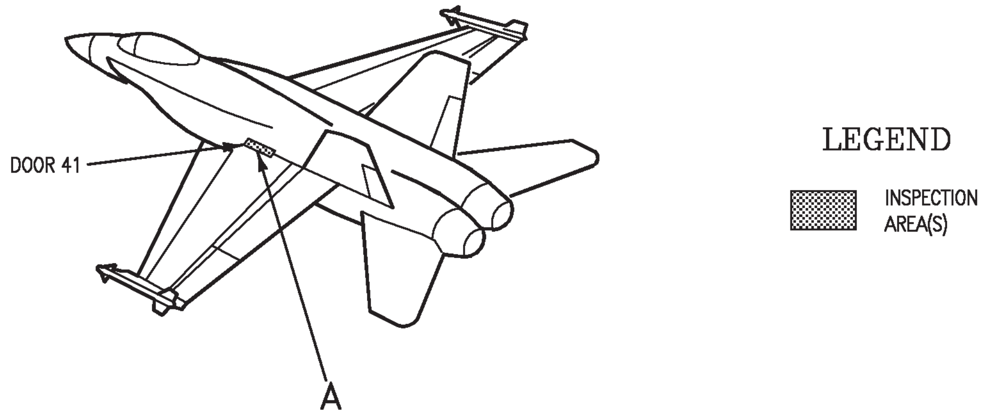
WARNING

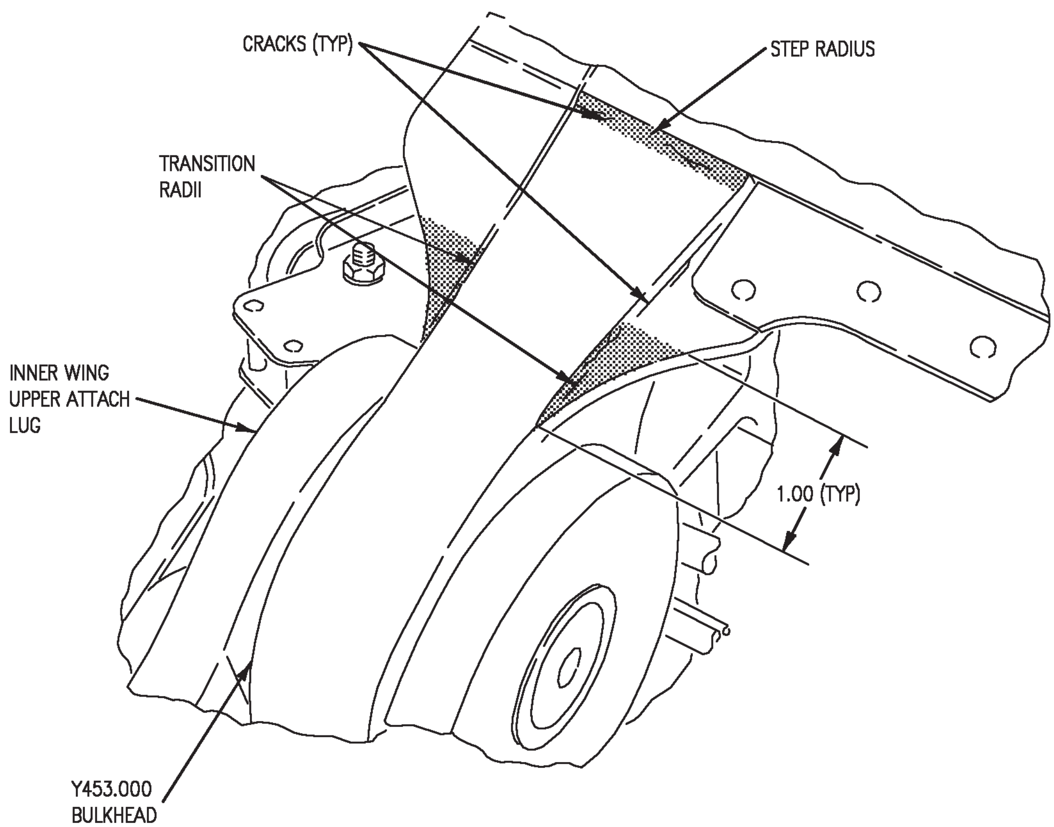
Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Clean inspection material from part with solvent moistened cloth.

b. Refinish inspection area(s) (A1-F18AC-SRM-500, WP012 00).

18. **SYSTEM SECURING.** Have door 41 reinstalled (A1-F18AC-LMM-010).

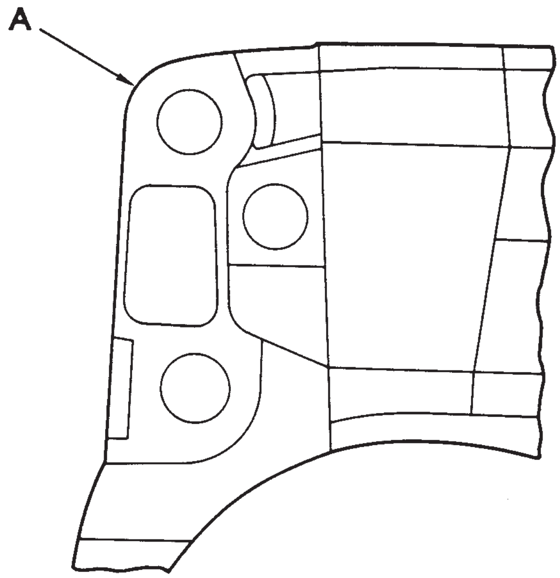




A

18AC-SRM-30-(138-1)34-SCAN

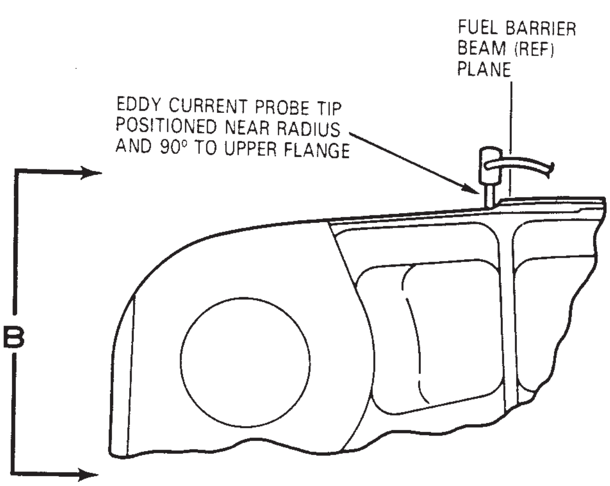
Figure 1. Center Fuselage Bulkhead Y453.000, Upper Flange Step and Transition Radii; Inspection Areas and Typical Flaws



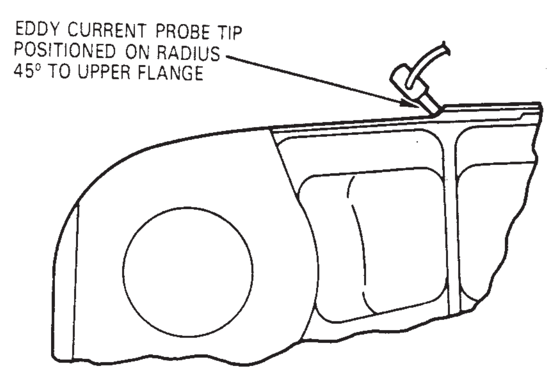
Y453.000 BULKHEAD
LOOKING FORWARD

LEGEND

INSPECTION AREA



PROBE POSITION 1



PROBE POSITION 2

A

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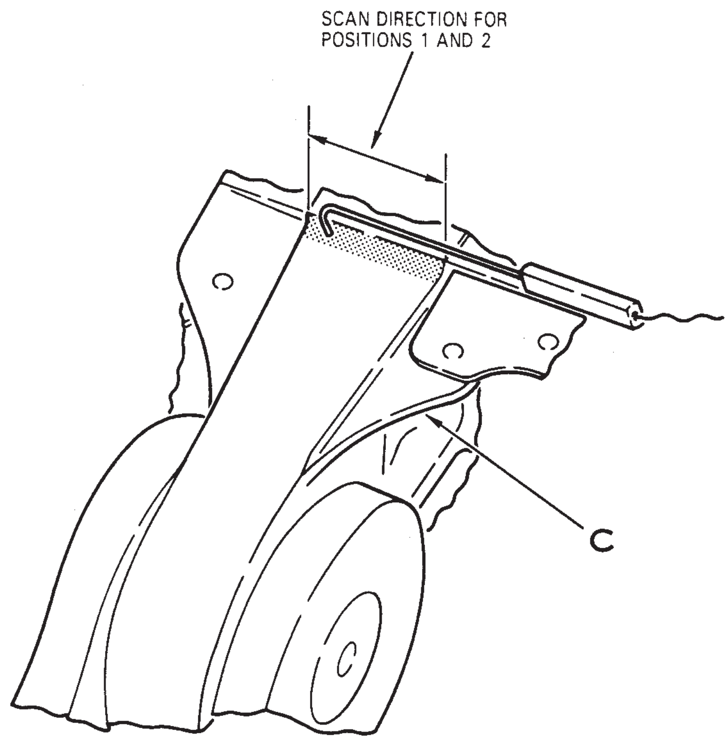
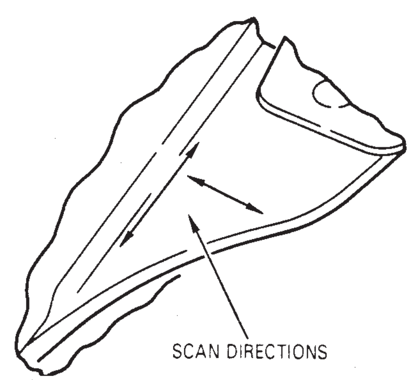
18AC-SRM-30-(139-1)

Figure 2. Scan Directions and Eddy Current Probe Positions (Sheet 1)



B



C

(U G)
18AC-SRM-30-(139-2)

Figure 2. Scan Directions and Eddy Current Probe Positions (Sheet 2)

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CENTER FUSELAGE BULKHEAD Y470.500, INNER WING LOWER LUG ATTACH POINT FATIGUE CRACKS

PART NO. 74A324204

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Structure Repair, Wing	A1-F18AE-SRM-600
Inner Wing Removal and Installation	WP047 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Finish System	WP012 00
Plane Captain Manual	A1-F18AC-PCM-000

Alphabetical Index

Record of Applicable Technical Directives

None

1. CENTER FUSELAGE BULKHEAD Y470.500, INNER WING LOWER LUG ATTACH POINT.

2. Center fuselage bulkhead Y470.500, inner wing lower lug attach point (attach point) is machined from 7075 aluminum plate. Installed in attach point is force mated copper beryllium bushing. Surface finish is ion vapor deposition (IVD) aluminum and epoxy primer coating.

3. **DEFECTS.** Inspect area around attach point for fatigue cracks, see figures 1 and 2.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have inner wing removed (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
Fabricate, See Figure 3	Eddy Current Reference Standard, Aluminum
6193	Multiple Coil Eddy Current Probe, Ideal Specialty Co.
1RR90F-6-1/2	Right Angle Surface Probe, GK Engineering
Fabricate, Figure 4	Wing Attach Lug Eddy Current Probe Guide

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth
MIL-P-8184	Acrylic Plastic, Sheet, Lucite Material 0.090 Inch

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

Do not remove bushing.

8. **Preparation of Part.** Clean inspection area(s) with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

WARNING

Make sure safety precautions are met for electrical, static, grounding when using eddy current equipment near aircraft fuel cells, oxygen systems, electrical systems, electronic systems, and stores (A1-F18AC-PCM-000).

9. **Equipment Settings/Standardization/Setup.**

a. For flat open areas around attach point, see figure 1, do ED520 Flaw Detector Setup (WP007 00) expect as below:

(1) Use 6193 multiple coil eddy current probe (probe).

(2) Use notch of aluminum eddy current reference standard (reference standard) to standardize, see figure 3, detail A.

b. For areas around attach point near edge, radius, or fastener hole, see figure 2, do ED520 Flaw Detector Setup (WP007 00) except use 1RR90F-6-1/2 right angle eddy current surface probe (right angle probe) and wing attach lug eddy current probe guide (probe guide), see figure 4.

10. **Inspection Procedure.**

a. For flat open areas around attach points see figure 1, do Inspection Procedure (WP007 00) except as below:

(1) Position, 6193, probe on flat smooth surface in inspection area.

(2) Use BALANCE to set meter needle to 250 microamperes.

NOTE

When probe is moved near edge of part, fastener hole, or radius, meter needle may gradually move down scale. If required, use BALANCE to return meter needle to 250 microamperes and scan parallel to edge or radius.

(3) Scan part in directions shown in figure 1. Scan at constant speed, no faster than speed used for standardizing equipment. After each scan, index 3/8-inch 90° to scan direction and repeat until complete area, see figure 1, has been scanned in required directions.

(4) Mark area(s) with aircraft marking pencil where sharp down scale deflection of meter needle indicates crack.

(5) Use 1RR90F-6-1/2 right angle probe and (WP007 00) to reinspect all marked areas to more accurately locate defects.

b. For areas around attach point next to an edge, radius, or fastener hole, see figure 2, do Inspection Procedure (WP007 00) except use 1RR90F-6-1/2 right angle probe and probe guide.

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Fluorescent penetrant inspection may be used to verify indications detected by primary inspection method. See figure 1.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

13. **Preparation of Aircraft.** Same as primary inspection method.

14. **Access.** Same as primary inspection method.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
ZA43 (TT10) (XMA101)	Portable Fluorescent Penetrant Inspection Kit
—	5 to 14 X Magnifier
M-16 (ZB-26)	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Mark Pencil
ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, and LARGE	Chemical Gloves, Rubber Gloves
AA1048TY1CL1GRIT 400X911	Aluminum Oxide Abrasive Cloth
MIL-C-87962, TYPE 1	Cleaning Cloth

15. **Preparation of Part.**

CAUTION

Mechanical or abrasive finish removal may cause damage to (IVD) coating, and corrosion of part.

a. Have finish system removed from inspection area(s) (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection area(s) with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

16. **Inspection Procedure.**

a. Do type I, method C fluorescent penetrant inspection (WP004 00).

b. After removing excess penetrant, spray thin film of developer on inspection surface.

c. Use black light and 5 to14 X magnifier to view inspection area for cracks.

d. Evaluate indications, mark location of any defect with aircraft marking pencil and record.

17. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

a. Clean inspection material from part with solvent moistened cloth.

b. Refinish inspection area (A1-F18AC-SRM-500, WP012 00).

18. **SYSTEM SECURING.** Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

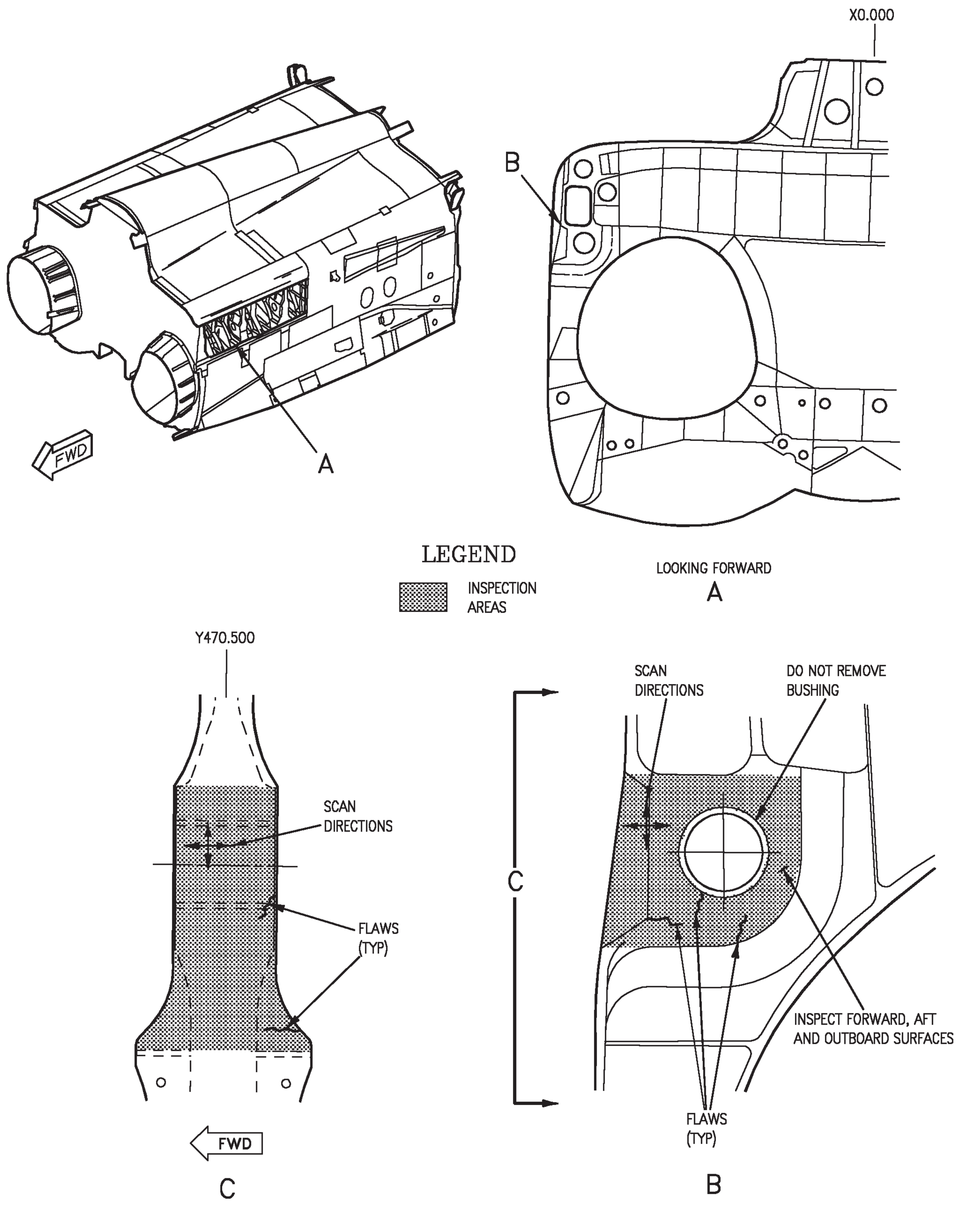


Figure 1. Center Fuselage Bulkhead Y470.500, Inner Wing Lower Lug Attach Point; Inspection Areas, Scan Directions, and Typical Flaws

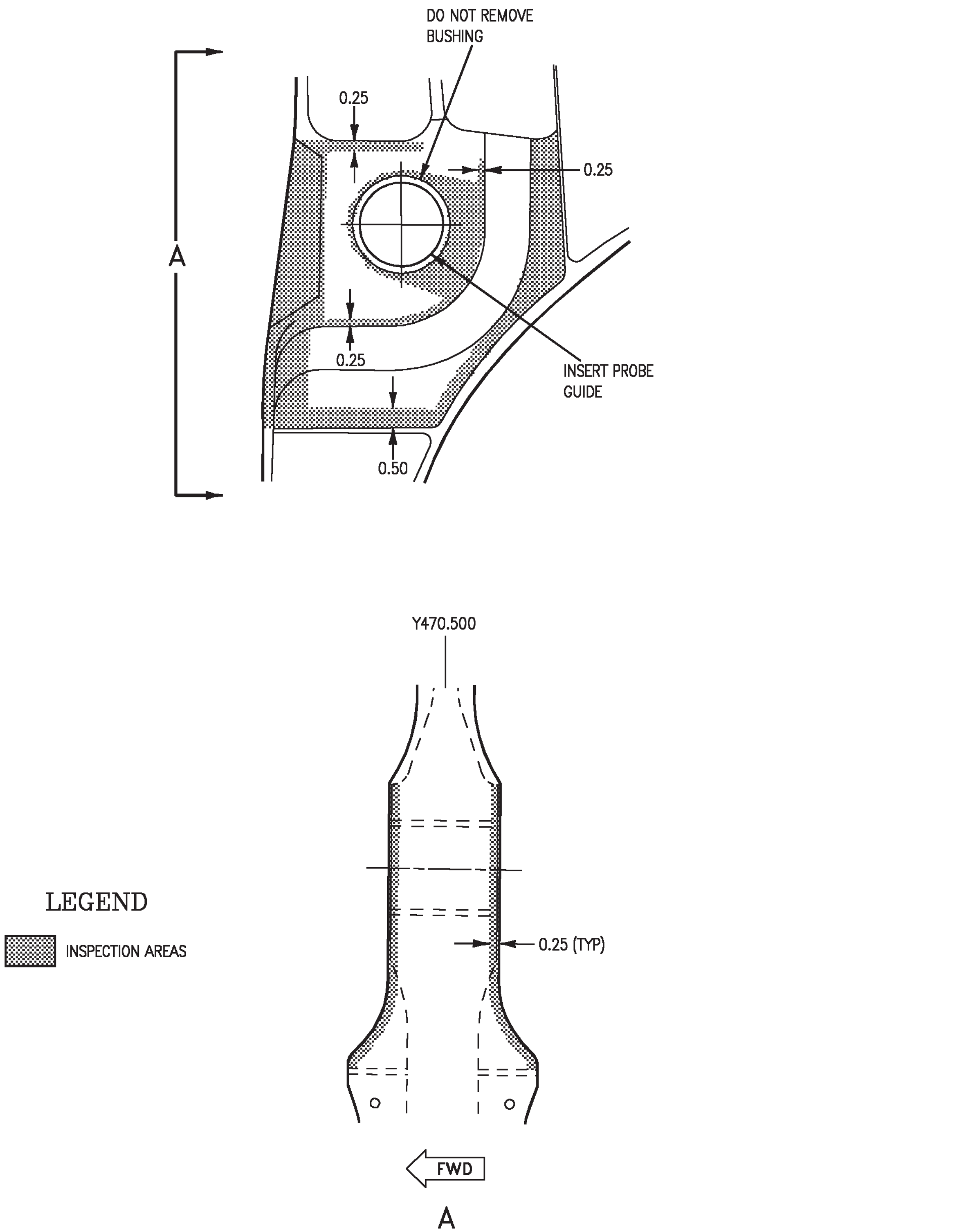


Figure 2. Right Angle Eddy Current Surface Probe Inspection Areas

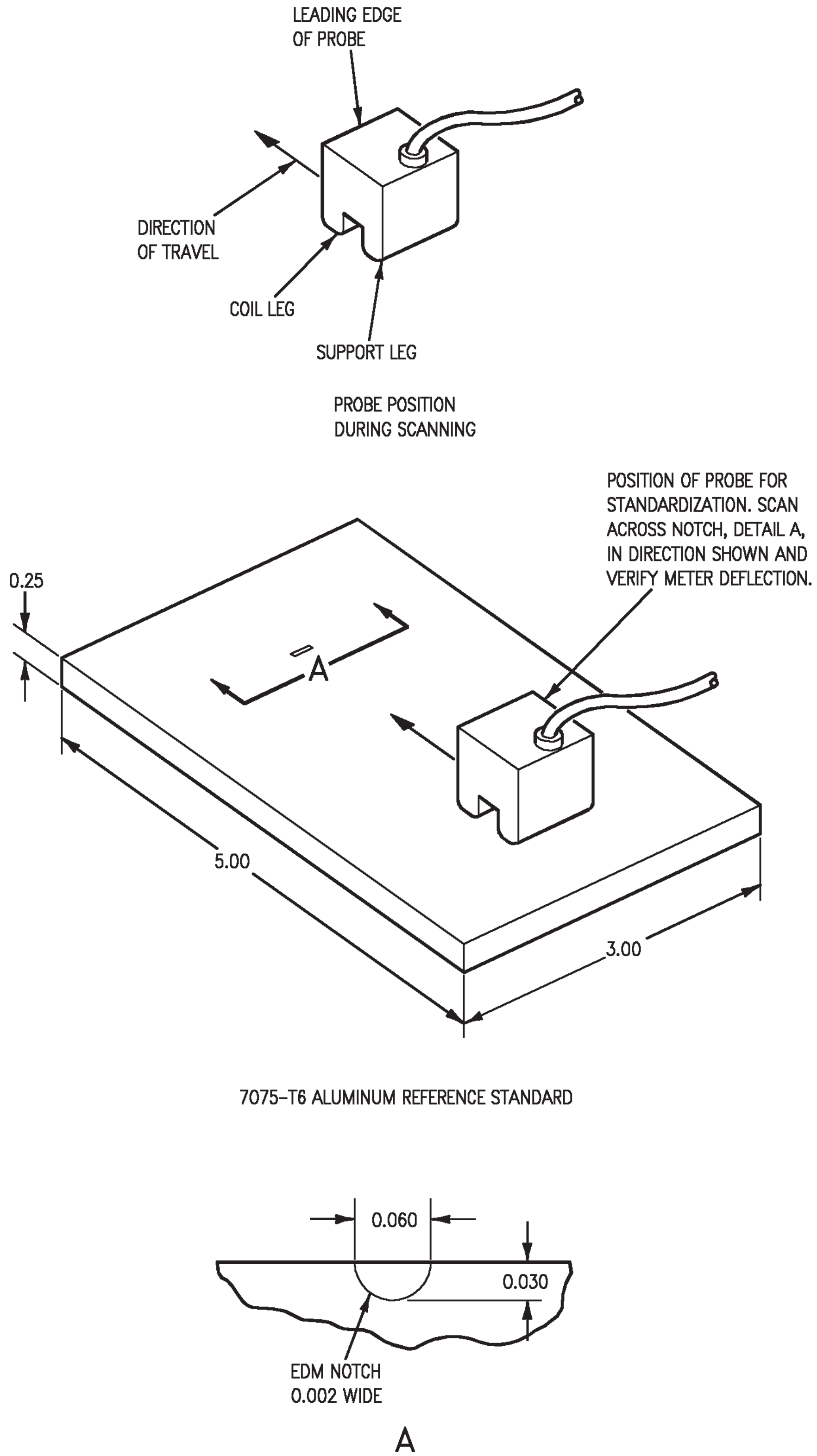


Figure 3. Standardization on EDM Notched Reference Standard

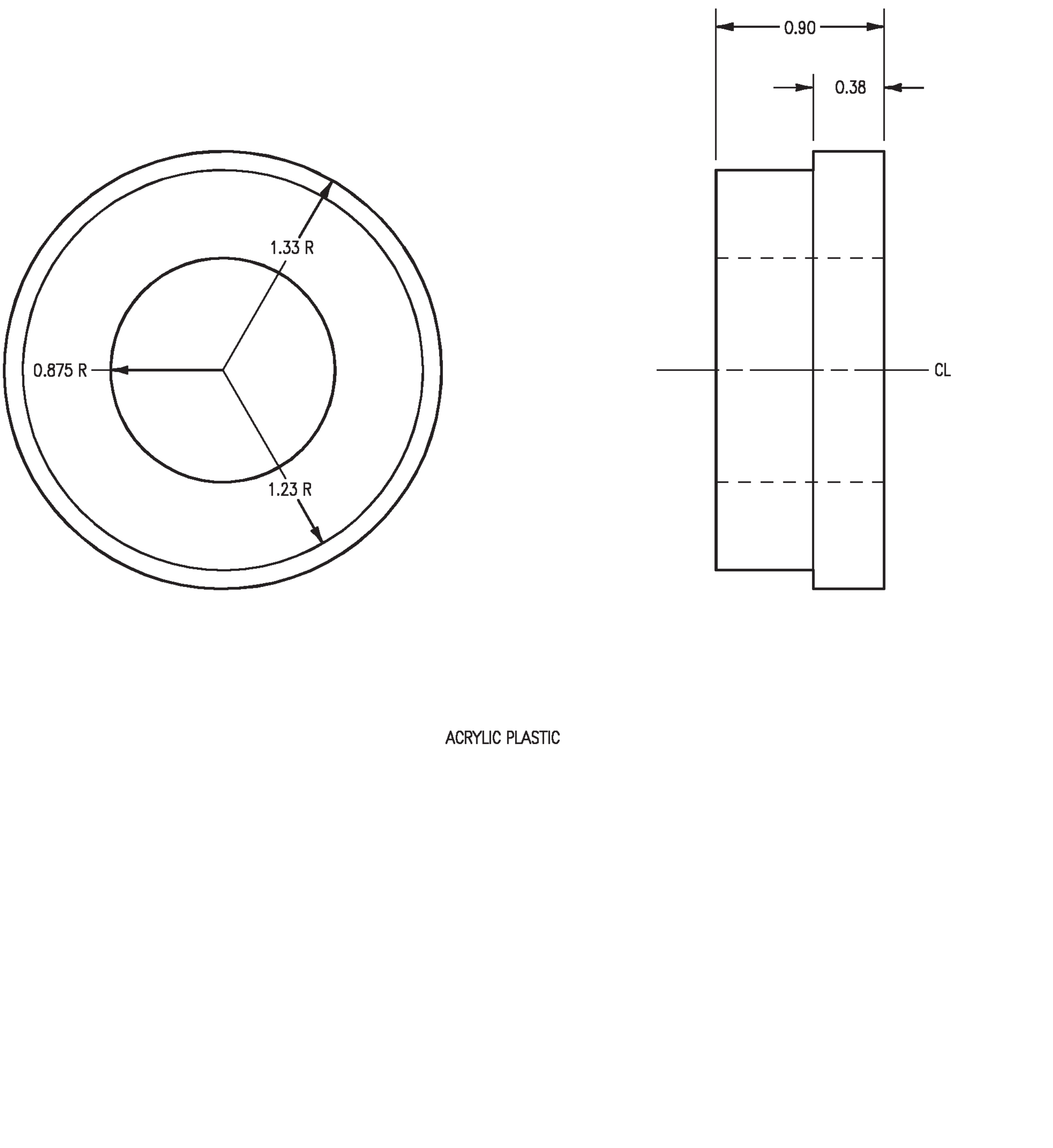


Figure 4. Wing Attach Lug Eddy Current Probe Guide

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CENTER FUSELAGE BULKHEAD Y470.500, CONTROL HOLE

FATIGUE CRACKS

PART NO. 74A324204

EFFECTIVITY: 161353 THRU 161704

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Power Plant and Related Systems	A1-F18AC-270-300
Removal and Installation - Middle Throttle Cables (3AAP657 or 3AAR658)	WP081 00
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00

Alphabetical Index

Record of Applicable Technical Directives

None

1. CENTER FUSELAGE BULKHEAD Y470.500 CONTROL HOLE.

2. Center fuselage bulkhead Y470.500, control hole (control hole) is machined from 7075 aluminum plate. Installed in control hole is force mated copper beryllium bushing. Surface finish is ion vapor deposition (IVD), aluminum, and epoxy primer coating.

3. **DEFECTS.** Inspect area around control hole for fatigue cracks, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.**

a. Have inner wing removed (A1-F18AC-SRM-210, WP025 00).

b. Have middle throttle cables removed (A1-F18AC-270-300, WP081 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
1RR90F-6-1/2	Right Angle Surface Probe, GK Engineering
— Fabricate, Figure 2	Control Hole Eddy Current Probe Guide

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1 CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth
MIL-P-8184	Acrylic Plastic, Sheet, Lucite Material 0.90 Thick

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean inspection area(s) with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** Do ED520 Flaw Detector Setup (WP007 00) using right angle surface probe (probe).

10. **Inspection Procedure.** Do Inspection Procedure (WP007 00) and as below:

NOTE

Do not remove bushing.

a. Position probe guide, see figure 2, in control hole from side of bulkhead to be inspected so edge of bushing is covered.

b. Position probe in flat smooth area away from bushing and use BALANCE to set meter needle to 250 microamperes.

NOTE

When probe is moved near edge of part or control hole bushing, meter needle may gradually move down scale. If required, use BALANCE to return meter needle to 250 microamperes and scan parallel to edge or radius.

c. Scan part in directions shown in figure 1. Scan at constant speed, no faster than speed used for standardizing equipment. After each scan, index 1/2 probe diameter 90° to scan direction and repeat until complete area has been scanned in required directions, see figure 1.

d. Mark area(s) with aircraft marking pencil where sharp down scale deflection of meter needle indicates crack and record.

e. Repeat steps a. through d. and Inspection Procedure (WP007 00) for opposite side of bulkhead.

11. **POST INSPECTION CLEANING AND CORROSION CONTROL.** Clean inspection marks, if required, from inspection area(s).

12. **SYSTEM SECURING.**

a. Have middle throttle cables reinstalled (A1-F18AC-270-300, WP081 00).

b. Have inner wing reinstalled (A1-F18AC-SRM-210, WP025 00).

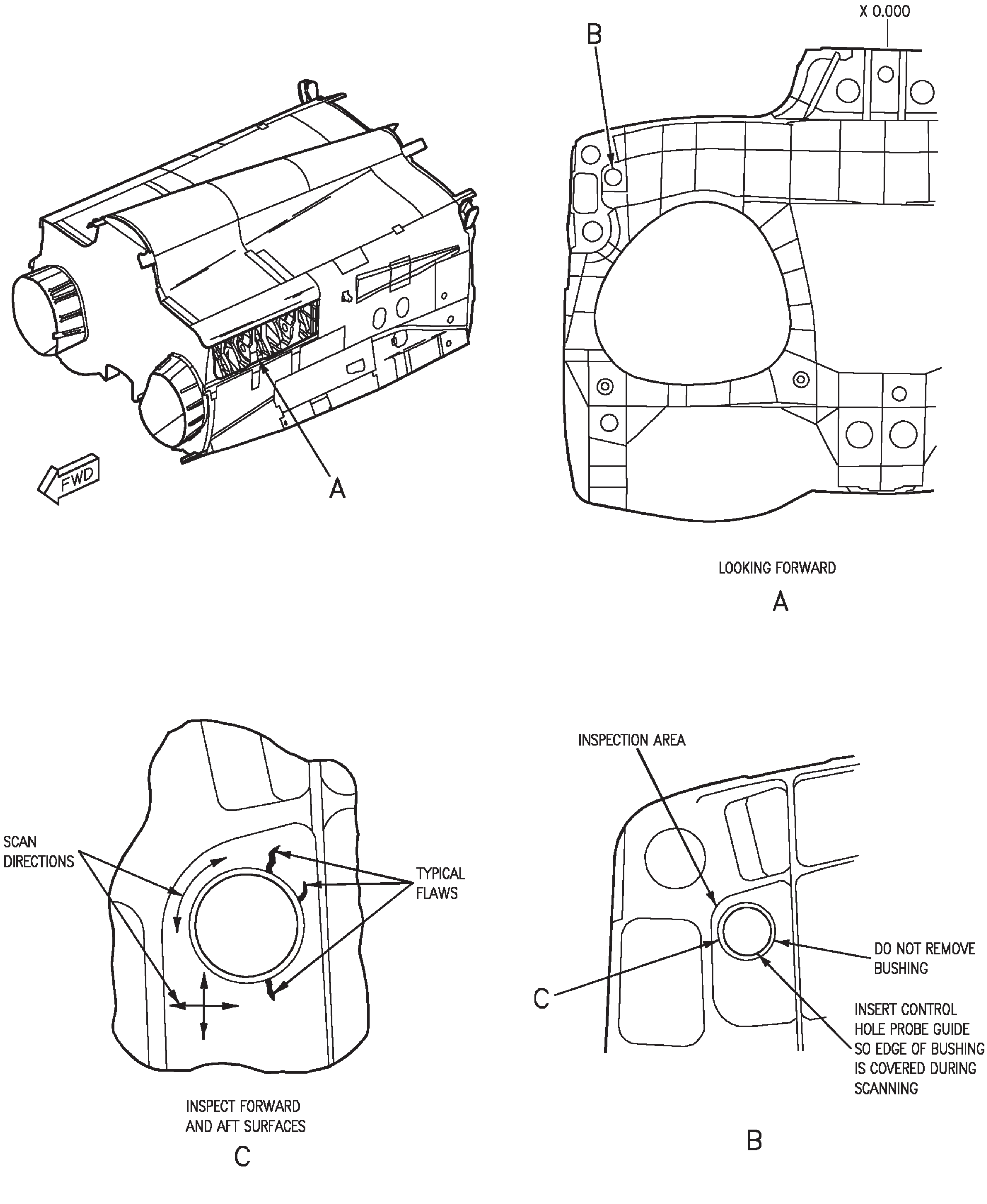


Figure 1. Center Fuselage Bulkhead Y470.500, Control Hole Inspection Area, Scan Directions and Typical Flaws

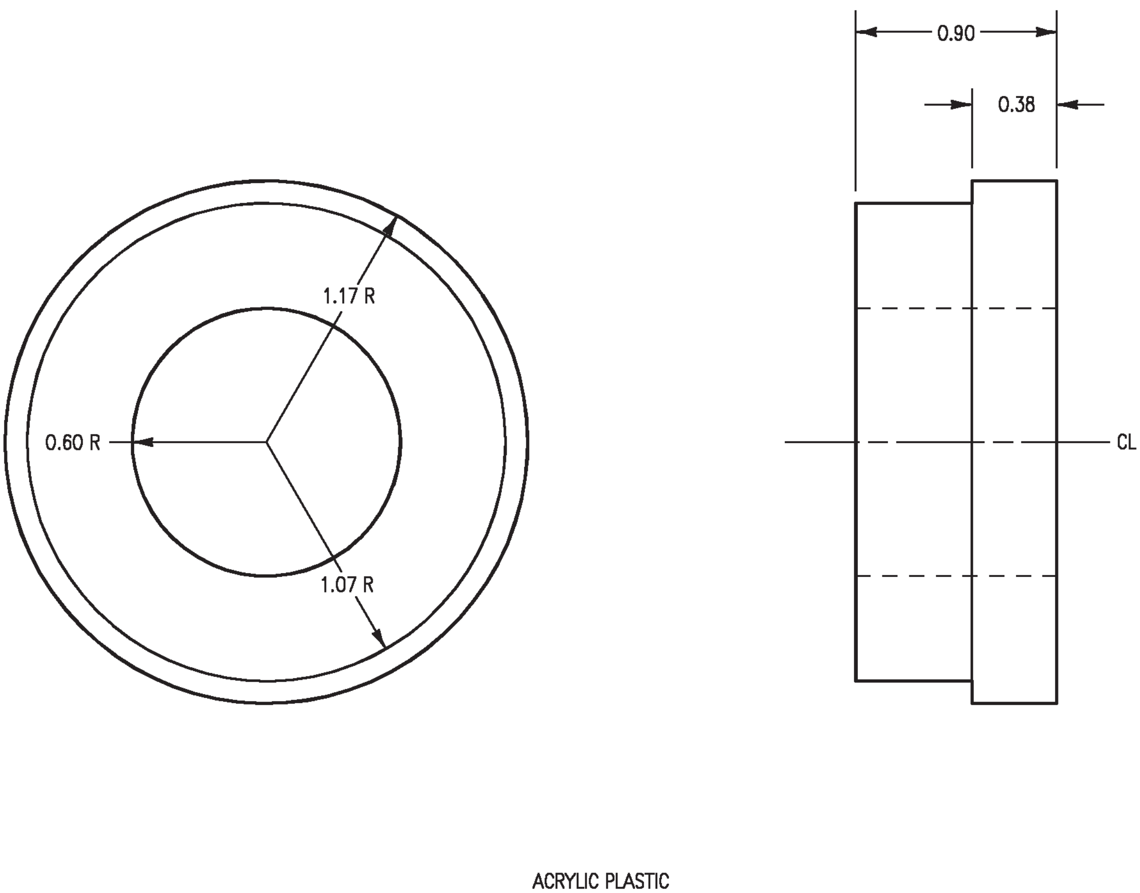


Figure 2. Control Hole Eddy Current Probe Guide

DEPOT MAINTENANCE

NONDESTRUCTIVE INSPECTION

CENTER FUSELAGE BULKHEAD Y470.500, UPPER FLANGE STEP RADII

FATIGUE CRACKS

PART NO. 74A324204

EFFECTIVITY: 161353 THRU 161704

Reference Material

Naval Aviation Maintenance Program	OPNAVINST 4790.2
Nondestructive Inspection	A1-F18AC-SRM-300
Eddy Current Surface Inspection of Aluminum Alloys	WP007 00
Penetrant Method	WP004 00
Aircraft Corrosion Control	A1-F18AC-SRM-500
Stripping	WP007 00
Finish System	WP012 00
Line Maintenance Access Doors	A1-F18AC-LMM-010

Alphabetical Index

Record of Applicable Technical Directives

None

1. CENTER FUSELAGE BULKHEAD Y470.500, UPPER FLANGE STEP RADII.

2. Center fuselage bulkhead Y470.500, upper flange step radii (step radii) is machined from 7075 aluminum plate. Surface finish is ion vapor deposition (IVD), aluminum, and epoxy primer coating.

3. **DEFECTS.** Inspect flange radii for fatigue cracks, see figure 1.

4. **PRIMARY INSPECTION METHOD.** Primary inspection method is eddy current.

5. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do eddy current inspections per OPNAVINST 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

6. **Preparation of Aircraft.** No special preparation required.

7. **Access.** Have door 41 removed (A1-F18AC-LMM-010).

Support Equipment Required

Part Number or Type Designation	Nomenclature
ED520	Eddy Current Flaw Detector, Magnatest
1RR90F-6-1/2	Right Angle Surface Probe GK Engineering

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
MIL-C-87962, TYPE 1	Cleaning Cloth

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

8. **Preparation of Part.** Clean inspection area with solvent moistened cloth to make sure inspection area is free of contamination or foreign material.

9. **Equipment Settings/Standardization/Setup.** Do ED520 Flaw Detector Setup (WP007 00) using right angle surface probe (probe).

10. **Inspection Procedure.** Do Inspection Procedure (WP007 00) except as below:

a. Position probe tip at base of radius as shown in figure 2, position 1.

b. Use BALANCE to set meter needle to 250 microamperes.

c. Scan part along radius as shown in figure 2.

NOTE

As probe is moved along radius and near edge of part, meter needle may gradually move up or down scale.

d. Mark area(s) with aircraft marking pencil where repeatable sharp down scale deflection of meter needle indicates crack.

e. Rotate angle of probe tip 45° and repeat steps a. through d., see figure 2, position 2.

NOTE

Use penetrant inspection to verify eddy current crack indications.

11. **BACKUP INSPECTION METHOD.** Backup inspection method is fluorescent penetrant. Fluorescent penetrant inspection may be used to verify indications detected by primary inspection method. See figure 1.

12. **Personnel Qualifications.** Personnel doing this nondestructive inspection should be qualified and certified to do liquid penetrant inspections per OPNAVINSP 4790.2 SERIES, NDI Technicians, NEC 7225/MOS 6044.

13. **Preparation of Aircraft.** Same as primary inspection method.

14. **Access.** Same as primary inspection method.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are shown indented.

Part Number or Type Designation	Nomenclature
ZA43 (TT10)	Portable Fluorescent
(XMA101)	Penetrant Inspection Kit
—	14 X Magnifier
M-16	Black Light

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
D 1153	Methyl Isobutyl Ketone
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MIL-P-83953-2, TYPE 1, CLASS A or B, RED or BLACK	Aircraft Marking Pencil
ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, and LARGE	Chemical Gloves, Rubber Gloves
AA1048TYICL1GRIT400 X9X11	Aluminum Oxide Abrasive Cloth
MIL-C-87962, TYPE 1	Cleaning Cloth

15. **Preparation of Part.**

CAUTION

Mechanical or abrasive finish removal may cause damage to (IVD) coating, and corrosion of the part.

a. Have finish system removed from inspection area (A1-F18AC-SRM-500, WP007 00).

WARNING

Dry cleaning solvent and methyl isobutyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

b. Clean inspection area with solvent moistened cloth to make sure inspection areas are free of contamination or foreign material.

16. **Inspection Procedure.**

a. Do type I, method C fluorescent penetrant inspection (WP004 00).

b. After removing excess penetrant, spray thin film of developer on inspection surface.

c. Use black light and 14 X magnifier to view inspection area for cracks.

d. Evaluate indications, mark location of any defect with aircraft marking pencil and record.

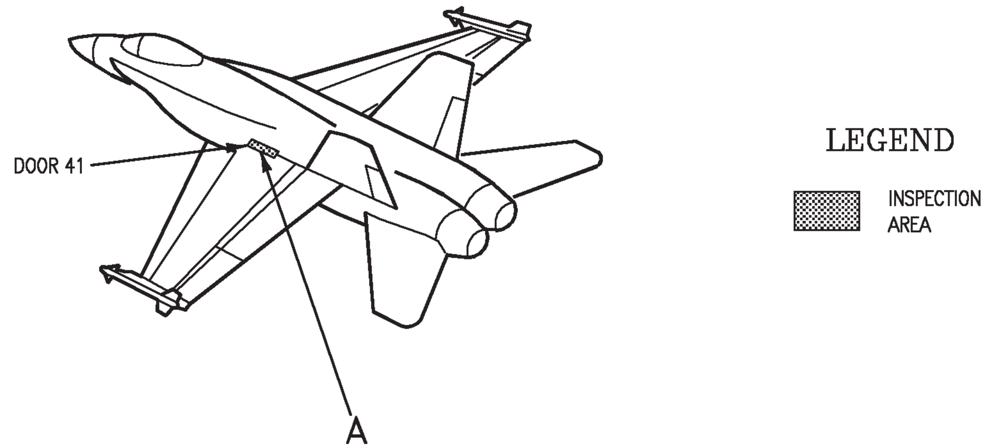
17. **POST INSPECTION CLEANING AND CORROSION CONTROL.**

WARNING

a. Clean inspection material from part with solvent moistened cloth.

b. Refinish inspection area (A1-F18AC-SRM-500, WP012 00).

18. **SYSTEM SECURING.** Have door 41 reinstalled (A1-F18AC-LMM-010).



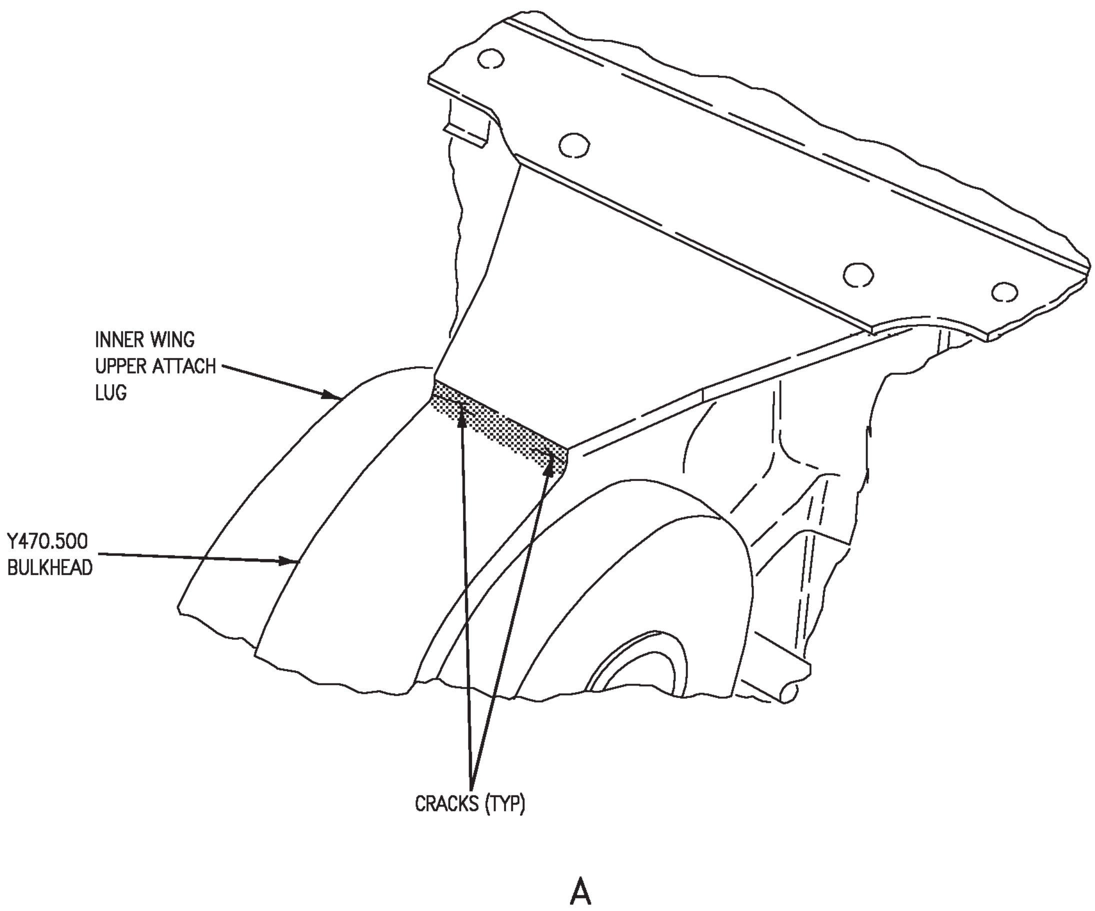


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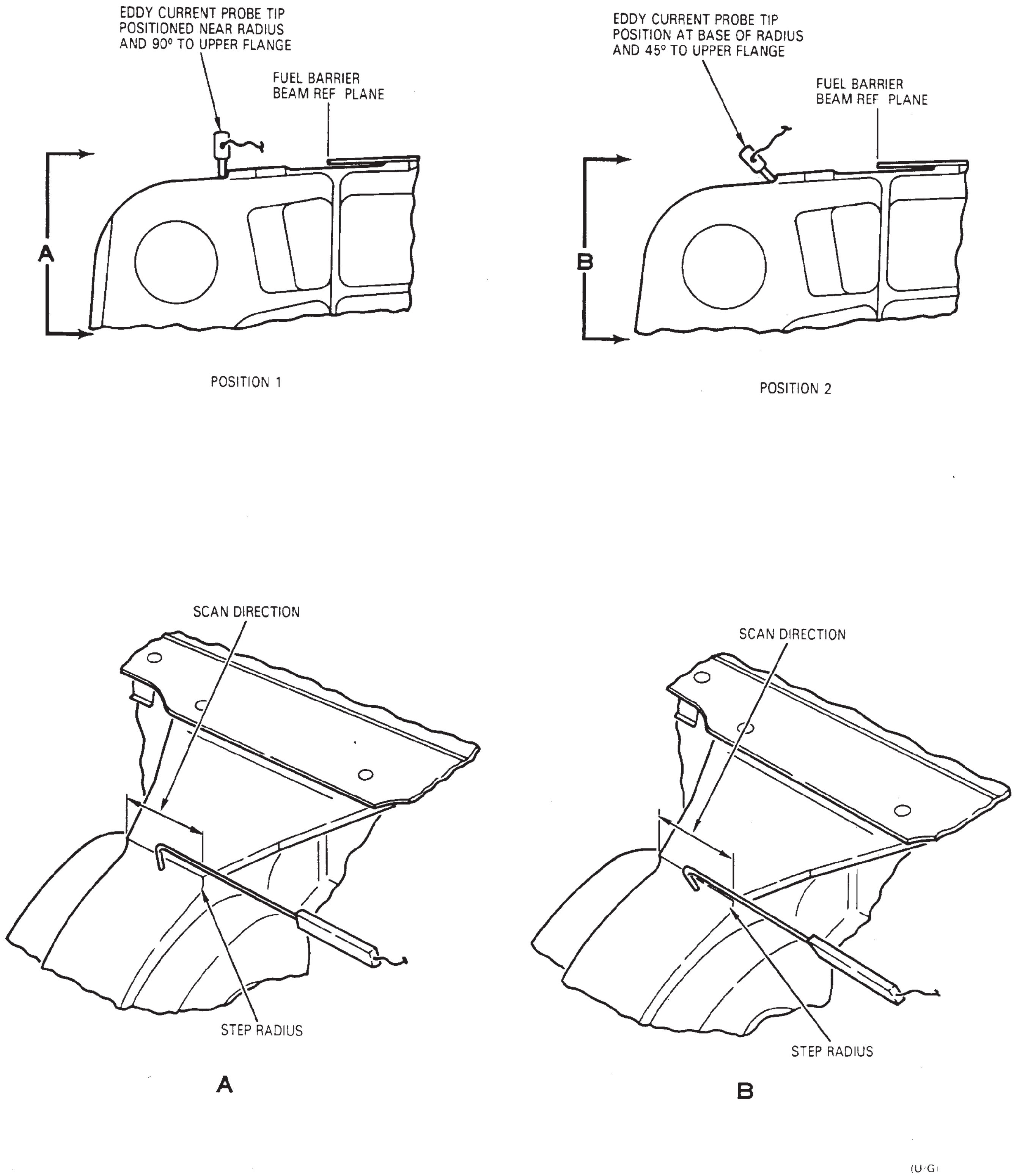
Figure 1. Center Fuselage Bulkhead Y470.500, Upper Flange Step Radii Inspection Area, and Typical Flaws



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18AC-SRM-30-(147)

Figure 2. Scan Direction and Probe Position